LIVE ARTICLES ON SPECIAL HAZARDS

No. 13

Weekly
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LIVE ARTICLES

ON

SPECIAL HAZARDS

No. 13

A Series of Articles Reprinted from the

Monthly Fire Insurance

Supplement of

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The Weekly Underwriter

1922

Price - - - - - $2.00

FOREWORD

In presenting Volume 13 of this popular series we wish to take this occasion to thank the contributors to The Weekly Underwriter who have made the publication of this book possible. Volume 13 contains an unusual number of especially interesting articles on fire hazards of an unusual sort.

The popularity of this series has resulted in the complete exhaustion of a number of the preceding volumes, so that they are not now obtainable from the office of the publishers. Several volumes are already in their second edition.

Every student of fire insurance should have a complete set of Live Articles on Special Hazards as far as he is able to obtain them. These books have the endorsement of the Insurance Institute of America and are found of inestimable value as reference books. A complete index of the entire series will be found at the back of this book.

Live Articles on Marine Insurance is recommended to students of that branch of the business. Live Articles on Suretyship, Lecture on Insurance, and Live Articles on Accident Prevention are recommended to those interested in the study of casualty insurance.

CONTENTS

BAKERIES

Processes and Fire Hazards Described—Growth and Development of Industry Traced—Record of Fires

By F. A. Cantwell, Chief Examiner New England Department, Queen Insurance Company

In 1919, the last year for which we have dependable statistics, bread and bakery products in the United States reached

OLD-STYLE ONE-OVEN BAKERY

the sum of $1,406,145,000. This was an increase of 186 per cent. over the preceding five-year period. And yet, less than twenty-five years ago the majority of bakeries were housed in the basements where the ventilation was exceedingly poor and the physical conditions far from sanitary; all of the work had to be performed by hand; the average working day for the baker varied from 12 to 16 hours and after he had mixed the

heavy dough in the heated atmosphere produced by the old fashioned ovens, the interior of the bakeshop was not inviting to the discriminating taste.

It is interesting to look at this industry in comparison with some of the other modern industries which provide for man's comfort and well-being. Taking a five-year period from 1914 to 1919, the meat-packing industry made an increase of 155 per cent. in the value of its output. Flour and grist mill products for the same period increased 150 per cent.; cotton goods 178 per cent., while bread and other bakery products made a gain of 186 per cent.

Iron and steel products increased 206 per cent.; steel ship building 209 per cent.; automobiles 275 per cent.; petroleum refining 315 per cent. But bakery products have risen from $491,893,000 in 1914 to $1,406,145,000 in 1919. A gain of near a billion dollars in five years, and when the statistics for the three years from 1919 to 1921 are available they will without doubt reveal more startling facts still.

There are approximately 4,000 bake shops in Greater New York. Of this number many are very small, especially those on the lower East Side of the city, some of which bake not over five barrels of flour weekly.

THE NEIGHBORHOOD BAKESHOP

Before taking up the larger bakeries let us realize that while the smaller shops represent individually only small insurable values, they do in the aggregate amount to considerable. As recently reported by the New York Department of Health the increase in the number of such bakeries in the last few years has added considerably to their work. Many of the old fashioned one-man bakeshops, the baking of which was done in the cellars with the ovens located under the sidewalk and doughnut kettles heated by the open gas flame, frequently in close proximity to combustible material, may yet be found in our cities.

The prohibition of cellar bakeries under the present Sanitary Code will in time do away with such places. However, the sale of bread from these shops has now to a large extent been reduced if not entirely taken over by the commercial and general baker who supplies the retail grocer, delicatessen and general stores and from whom the consumer now makes his purchases.

These small shops in the past have had numerous fires, owing probably in a large measure to the hazards of the doughnut kettles, defective ovens, general crowded condition and uncleanliness.

The retail baker having practically lost the sale of his most important product, viz., bread, to the commercial companies,

has been forced to seek new avenues of revenue and has now converted his shop into a lunch room and bakery and many such establishments may now be found in the larger cities.

PORTABLE GAS OVENS

The advent of the portable gas oven in this industry particularly in the smaller shops has in recent years made for considerable changes, in many cases for the better, when care has been exercised in proper installation, usually on the grade floors, with better light and ventilation and often within public view. All this tends to decrease the physical hazard. It is a vast improvement over the gas lit, poorly ventilated, untidy cellar shops. There is no good reason why the small

MIXING ROOM IN MODERN BAKERY

bakery should not be modernized in these days of machine made articles.

Philadelphia claims credit for having the two largest bakeries in this country, one using about 2,500 barrels weekly and the other over 3,000.

The New York baking trade has experienced some changes, in that several of the largest plants have combined. The total weekly flour consumption of these is estimated at 12,000 barrels.

Another company taking in 21 plants in New York City

and State has further changed the complexion of the New York bakery trade. This company consumes 10,000 to 12,000 barrels of flour weekly.

Such plants represent large insurable values and it is the purpose of this paper to describe the processes and hazards found in this class of risk and to make suggestions as seem necessary to safeguard this industry from loss by fire. The chief hazards are represented by the *various baking ovens and cooking kettles.* The other hazards are mostly those connected with the various classes of shop work necessary for the upkeep of the plant and equipment, namely, machine shop, carpenter shop, tin shop, cooper shop, wood and paper box making, blacksmith shop, stable and garage. There may also be a laundry, chemical laboratory and artificial refrigerating apparatus. Large bakeries are nearly always located in cities. A location in a closely built part of the city is not necessary however, as local deliveries can be made efficiently from a point outside the conflagration district.

A site outside the conflagration area is desirable.

CONSTRUCTION

No general type of construction is common to bakeries. All classes of construction from the best to the most inferior are in use by this industry.

The very large bakery, occupies an extensive plant, the buildings varying in height from one to ten stories of fire-resistive construction and sprinklered. The average bakery is usually of basement two and three-story brick joist construction and many of these plants are now sprinklered.

A good type of construction for this business is a three-story main building of brick mill construction with a well cut off, one-story or two-story fire-resistive addition, for the baking and cooking processes. Garage, stable, storehouse, smithy, etc., should be detached. In the mixing and packing sections of a bakery floor openings for chutes, conveyors, and hoists are likely to be numerous. To protect these openings in such a manner as to prevent the possible spread of fire from floor to floor requires special treatment. The best method of doing this appears to be to have the conveying apparatus in a metal enclosure with automatic closing doors at each end. Conveyors opening through fire walls should receive similar treatment. Electric power is commonly used and is most desirable. Bread bakeries usually run night and day while cracker bakeries run days only.

PROCESSES AND HAZARDS

The baking industry may be divided into two general classes, namely, bread bakeries and cracker bakeries. Bread bakeries produce bread and often pies, cakes and doughnuts,

all of which are more or less perishable products. Cracker bakeries produce hard and soft crackers, plain and fancy cookies, etc., which are to a certain extent of a non-perishable nature. The distinction between the two classes is well defined in the baking trade and one plant rarely produces both classes of goods. The raw material used and the processes of manufacture are so closely related however, that a close distinction between them will not be made in this paper.

RAW MATERIALS

Flour is the chief ingredient and is usually shipped to the plant in bags by the carload. Sugar and salt are also received in bags, the other raw materials come in various containers such as barrels, wood and paper boxes, metal cans, bags, etc. Often these raw materials are stored in large quantities in the basements and other convenient floor space in the main buildings. It is much better practice to have these materials kept in a separate storehouse built for that purpose.

FLOUR BLENDING

The flour is frequently a blended mixture of several good brands to get a proper and uniform percentage of gluten and starch. This may or may not be done at the plant. The operation is one of sifting and mixing and takes place inside a wood or metal enclosure. The blended flour is conveyed mechanically to bins or hoppers which feed the dough mixers. The sifting and blending present a slight dust hazard, but one not serious if well arranged.

BAG CLEANING

After the contents have been removed from the flour bags, the dust may be shaken out of the bags by hand or the bags may be suspended in a bag-cleaning machine which beats out the dust and blows it into a suitable receptacle. This apparatus is tightly enclosed and none of the dust escapes to the room. The use of such a machine is important from the point of cleanliness as it prevents large quantities of dust from collecting on the floor and about the room.

DOUGH MIXING

Dough is mixed in mechanically driven mixing machines, usually built of cast and sheet iron having a capacity of one to five barrels each. The mixing drum contains agitators which mix and knead the dough. Each one may be operated by a motor attached to the base plate. Along the side of a group of mixers, there is usually a raised platform from which the operatives deposit the various ingredients into the mixers. Directly over each mixer there is a weighing hopper which is fed by a spout from a flour bin or conveyor. There is also a liquid weigher over each mixer. There are no

hazards in the mixing process other than those incidental to the moving machinery.

PROOFING AND FERMENTATION

Proofing may be said to mean "to raise the dough." It is a fermentation process caused by the addition of the yeast and occurs in bread dough and sponge cracker dough. It is accomplished by allowing the dough to set in a warm room for a period of several hours. The room is especially built to maintain an even temperature near 80 degrees F. Steam or hot air heat is used and in some cases a system of ammonia refrigeration pipes are provided to cool the room to 80 degrees on excessively hot days. This process is not hazardous as the operating temperature is low.

DIVIDING AND MOULDING

This work is done mechanically by automatic machines which cut up, knead and shape the dough to the size and forms which will make the final loaves. These machines perform their functions by rolling the doughs in the form of round or oval balls between two flat metal surfaces, belt conveyors carrying the loaves from one machine to another. Each time the doughs are worked they lose some of their "life and size" so further fermentation is required. After being moulded the loaves proceed on an endless belt through a so-called proofing cabinet which is usually built of metal and glass and heated to a temperature of about 90 degrees. It takes 20 to 30 minutes for the loaves to pass through this cabinet, during which time they regain considerable life and size. The loaves then proceed to the final moulding and forming machines from which they are placed in the baking pans. These are then placed in metal racks and run into a final proofing room, which is a tight enclosure equipped with steam coils and steam jets and kept at a temperature of 85 to 90 degrees. The loaves remain in this proofing room about one hour, recover the life and size lost in the final moulding process and are ready for baking.

ROLLING, CUTTING AND STAMPING

Sponge cracker dough contains yeast, therefore requires a period of fermentation which takes place in a warm room. The dough is then removed to the baking rooms where it is worked between mechanically driven rollers called brakes. Then it is placed in cutting and stamping machines which roll it out to the desired thickness and deposits it on a traveling belt where it is mechanically cut and stamped to the desired design as it passes along. The crackers are collected by operatives on wooden paddles and deposited in the oven. Crackers which are easily breakable are collected on metal trays and baked in the trays.

PIES, CAKES, COOKIES, DOUGHNUTS

These goods do not contain yeast, so no period of fermentation is required. Otherwise the preparation of the dough is practically the same as has been described. Often, however, the pie and cake business are side issues in which case these departments have but little automotic machinery, much of the work of kneading and forming the dough being done by hand. Pies are cooked in metal or paper plates. The pie plates are placed on pie crust rimming machines which shape the crust and rim the edges, while operatives pour the fillings into the pies by hand.

The cake business is frequently the least profitable and least important and therefore will receive the least attention and supervision. The machines and ovens are likely to be the older types and in poor repair.

FILLINGS

The fruit or berry fillings for pies, cakes or cookies are cooked or stewed in steam jacketed copper lined kettles. Canned fruit and berries are largely used. When fresh fruit is used special machinery is required to prepare it, such as peelers, seed extractors, cutters and choppers.

Chocolate, frostings and other candy coatings are also cooked in steam, jacketed kettles. Steam pipes for heating steam jacketed kettles should be properly brushed and kept clear of combustible materials. If the kettles are gas heated the burners should be fed by fixed piping securely supported. Floors under all cooking kettles should be protected by sheet metal or other suitable materials.

The process of placing the fillings or coating on the cakes or cookies is called icing. This is commonly done by squeezing the contents of suspended bags out through small holes so arranged that the soft material deposited on the object will assume a certain form or figure. This is done by operatives, as the cookies pass along on a traveler.

These are cleaned by a pan cleaning and greasing machine, which consists of a series of revolving brushes by which water or grease may be applied. A composition, the base of which is low grade lard or cotton seed oil, is used for greasing pans and is usually applied cold.

TYPES OF BAKING OVENS

The baking ovens may be stationary or portable, the distinction being that the stationary oven is large and is built as part of the building, while the portable oven is smaller in size and can be moved if desired. The stationary ovens are usually of substantial construction built of fire brick, tile and soap stone, and are carefully made to withstand the continued heat and confine it to the oven. The side walls are masonry,

18 inches or more thick. The top and bottom are also of brick with a heavy thickness of sand to retain the heat.

The portable ovens are less substantial in construction and are usually built of double sheet steel packed with heat-retaining material. The different types of ovens vary chiefly in the arrangement of the baking chamber. Practically all types of ovens may be built either stationary or portable.

PEEL OVEN

The ordinary bread oven, also called the peel oven, has the fire box at the bottom and is fired from either the front or the rear. The baking chamber is directly over the fire box, but separate from it and is heated from the fire underneath and numerous flues which pass around the sides and over the top and carry the smoke and fumes to the chimney. There are dampers in each flue so that the amount of heat in any part of the oven may be controlled. The baking surface is of brick, tile or soap-stone and is often inclined to the door to facilitate placing the loaves in and removing them from the oven. The loaves are placed in and removed from the oven by means of wooden paddles with long handles called "peels." Hence the name "peel oven." This type of oven is commonly used in large plants for baking bread.

OPEN HEARTH OVEN

In this type of oven the fire is built in one corner of the baking chamber over a grate, under which there is an ash-pot. The fuel is usually coke, but may be hard coal or wood. After the oven is heated to the desired temperature, the fire is allowed to die down and the dampers and flues closed; then the articles are baked by the heat confined in the oven. This type of oven is commonly found in small bakeries where it is used for all classes of baking. In large bakeries the are sometimes used for baking cake.

ROTARY OVEN

In the rotary oven the baking surface revolves in a horizontal plane about a vertical axis. By revolving the baking surface any article in the oven can be brought directly in front of the oven door. This fire pot is at the bottom directly under the baking surface and the same chamber with it and has side and back flues. The furnace door may be at any side. This oven is particularly adapted for baking pies.

REEL OVEN

The baking surfaces in the reel oven consist of a series of sheet metal plates suspended on horizontal axis between the outer rims of two large wheels which turn about a horizontal axis. By turning the wheels any baking surface can be brought directly in front of the oven door. The fire pot is at the bottom and in the same chamber with the baking sur-

faces. It has back and side flues. This oven usually extends through two stories and is fired from the lower floor and is operated from the upper floor. The reel oven is commonly used for baking crackers and cookies.

OTHER KINDS OF OVENS

The baking surface in the traveling oven is in the form of an endless metal traveller which passes horizontally through a long oven, over a furnace. The articles to be baked pass in at one end and out at the other end. The speed of the traveller may be adjusted so that the articles will remain in the oven the proper length of time. This oven can be used for all classes of baking.

The baking chamber of the rack oven consists of a series of metal racks or shelves, one above the other upon which the articles to be baked are placed. The fire is at the bottom and the heat is regulated by side flues.

Nearly all ovens are equipped with indicating thermometers and electric or gas light which extends into the baking chamber. Many ovens have steam jets in the baking chambers, which moistens the air and imparts a glossy surface to the articles being baked.

Coke or hard coal is the most common fuel used to heat the ovens. Wood is sometimes used. Fires in most ovens are kept burning constantly. Natural or public gas is a satisfactory fuel when it is not too expensive. For small portable ovens it is in common use.

HAZARDS OF OVENS

Ovens furnish the most serious hazards in bakeries. Over 25 per cent. of the fires in this class of risk are attributed to poorly located defective or poorly cared for baking ovens. Their construction, location and arrangement should receive careful attention. The hazard of a baking oven corresponds to that of a low pressure boiler and it is poor practice to locate one in a combustible building.

The following precautions for guarding the hazards are most important:

The oven should be of substantial construction, designed to retain the heat inside.

Adequate foundations of absolutely incombustible materials should be provided.

Floor in front, back and sides to be incombustible.

Ample clearance to ceiling, ceiling to be incombustible if possible.

Ample clearance to walls and partitions.

Woodwork and incombustible material to be kept away.

Properly built chimney.

Oven flues and chimneys should be thoroughly cleaned out at frequent intervals.

Proper care of ashes.

The oven should be located in a cut-off fire-resistive section of the plant if possible, and no combustible material should be allowed in the oven section. If this cannot be done the best arrangement is to have a cut-off section of slow burning or mill construction, but they must be carefully insulated from all woodwork. If the ovens are in the main building, the following precautions should be observed:

Stationary ovens located in *fireproof buildings* should be supported on special foundations provided in the framing of the building. The wooden top flooring and nailing strips should be removed from underneath the oven and for a distance of not less than 8 ft. in front and replaced with concrete laid directly on the floor arches.

If there is a story above, there should be a freely ventilated space of at least 12 inches between the top of the oven and the ceiling.

Stationary ovens located in *combustible buildings* should have special foundations and should be preferably located on the first floor. The ovens should set on incombustible floor and wood-flooring, joists, beams, girders, etc., should be removed for not less than 3 ft. at the sides and back and not less than 8 ft. in front and be replaced by concrete and steel brick arch or other incombustible construction. The ceiling over the oven should receive precisely the same treatment and there should be a clearance of at least 12 inches between the top of the oven and the ceiling.

If a wooden ceiling is allowed to remain over a top of an oven, there should be a well ventilated clearance of at least 4 ft. No wooden partition or other combustible material should be allowed near the ovens. The charging door (through which the material to be baked is fed) usually consists of a long horizontal opening about 18 inches high. A metal hood with a metal vent pipe communicating to the outside should be provided over this opening to carry off heated air and gases which escape when the door is open. This is very important when the ceiling above is combustible, as sufficient heat frequently escapes through this door to ignite the ceiling above or other combustible material nearby.

Ovens which extend through two floors, such as reel ovens, should have the same sort of clearance provided at each floor and the ceiling as specified above. Frequently ovens are fired from the rear, in which case the firing space of 10 ft. or more between the back of the oven and the wall should be entirely of fire-resistive construction. This is a good arrangement

from the point of cleanliness, as the fuel and the ashes are kept away from the goods in process.

Portable ovens are not considered as safe as stationary ovens. They have usually double sheet iron walls packed with insulating material, and are supported by a metal frame on iron legs. The fire-pot and ash-pit may extend down to a few inches above the floor. They are frequently set in the corner of a room with very slight clearance to wooden partitions. Portable ovens vary greatly in size and construction, therefore the degree of protection varies. To insure perfect safety practically the same precautions should be observed as prescribed above for stationary ovens.

Inside chimneys used in connection with bake ovens should have brick walls not less than 8 inches thick lined with one inch of fine tiling. The throat area should be sufficient to prevent undue heating.

Outside chimneys may be of metal provided they are self-supporting and have ample clearance to combustible material. Fuel should be kept outside or in an incombustible well ventilated vault or bunker.

Ashes should be placed immediately in metal barrels and removed from the building. Ovens, chimneys and flues should be thoroughly cleaned out at frequent and regular intervals. Space at the top and all sides of the ovens should be kept free from all rubbish or storage of any nature.

DOUGHNUT KETTLES

Kettles for frying doughnuts, crullers or fried cakes have been the source of many bad fires. These kettles are almost invariably heated by open flame and if not closely watched the fat becomes too hot or boils over, resulting in a bad fire. These kettles should be located in a specially built cut-off room of fire-resistive construction. Floor and ceiling should be incombustible. Floor should drain to safe place outside. Door opening to room should have a curb or sill 4 inches high. There should be metal hoods over the kettles piped to carry the heat and fumes outside. The kettles should be substantially constructed and well set and should be equipped with thermometers and thermostats to indicate and regulate the temperature of the fat. In some cases overflow pipes terminating in a safe place may be used to safeguard the kettles. The safest form of kettle is one set in brick walls, so that if it boils over the contents cannot reach the flames. Such a kettle is fired from the outside. If the fuel is city gas all piping and connection should be rigid and substantially supported. If an oil pressure system is used it should be installed in strict accordance with the rules of the National Board of Fire Underwriters.

PACKING

Bread: After baking the loaves are allowed to cool in an open room for a short time and then proceed on a belt conveyor to the packing room, where they are wrapped in wax paper either by hand or by wrapping paper machines. The wrapping machines fold the paper over the loaf and fasten it by means of a hot plate, electrically heated which melts the wax and causes the ends to stick together. One machine can wrap from 30 to 50 loaves a minute. The bread is then packed in boxes, barrels, metal or paper boxes for shipment. Pies usually supplied to local trade only are not often wrapped or packed. Cake may receive the same treatment as bread.

Crackers and cookies are to a certain extent of a non-perishable nature, so do not have to be shipped as baked. If the crackers are not easily breakable, they are usually raked from the ovens onto belts conveyors which carry them to long tables in the packing room where they are placed in the various containers by girls. If they are easily breakable, they are conveyed to the packing room on the metal trays in which they are baked. Square tin boxes with glass faces are commonly used to hold crackers or cookies. Barrels, wood and paper boxes are also used.

SHIPPING

In bread bakeries the product requires immediate distribution, therefore large loading space is necessary and an extensive equipment of delivery trucks or wagons is needed. From 50 to 150 delivery carts may be required to handle the output and these may be stored and cared for at the plant. This department may represent over 20 per cent. of the investment expense.

GARAGE AND STABLE

For repairing and storing of automobile trucks should be well detached or cut off from the main plant, and the construction, equipment and operation should conform in all respects to the present day standards for that class of work. If the loading and shipping section is a one-story addition well cut off from the main buildings, the delivery trucks may be allowed to rest in storage there at night. The stable, if any, should be a detached or cut-off building used for that purpose only.

MACHINE SHOP

A small machine shop is necessary for making and repairing machinery. This room should be kept neat and clean. A covered metal box should be provided for clean waste and standard covered metal waste cans for oily waste, the latter to be emptied each night.

Working supply of lubricating oils should be kept in substantial metal tanks made for that purpose. Large quantities of oil should not be kept inside the building.

CARPENTER AND PAINT SHOP

In some cases the bakery provides show cases for their retail customers and the making and repairing of these cases may be done at the plant involving woodworking, painting and varnishing. Wooden packing cases, previously mentioned, also involve carpenter work. Approved means should be provided to remove the sawdust and shavings. Space under benches should be kept clean and free from rubbish. Glue pots should be safely arranged. Large quantities of paint and varnish should not be kept inside the building. Working supply of paint and varnish should be kept in a substantial metal cabinet built for that purpose. A covered metal box should be provided for clean paint rags. Used rags should be placed in standard metal safety cans and disposed of each night.

LAUNDRY

Employes frequently wear white suits provided by the plant. Two or more changes are provided each. These may be laundered at the plant. The clothes dryer should be preferably all metal, but if wood it should be thoroughly lined with asbestos and metal, including the floor. The steam pipes should be properly brushed and kept clean of woodwork. If there are steam pipes inside of the dryer metal screens should be provided to keep the contents from contact with the pipes.

CLEANLINESS

The general care and cleanliness through the plant should receive high class supervision. A good supply of metal barrels should be provided for waste and rubbish, and these should be emptied each day and carted away. A bakery soon becomes a dirty place unless a force of sweepers and cleaners are kept constantly at work, and this feature needs particular attention. The standard of cleanliness in bakeries seems to be somewhat below that of the average high-class manufacturing plant. Some bakeries are spotless, however, and leave nothing desired in this respect, showing that it is possible to maintain a high standard of cleanliness of this class of business if sufficient effort is made.

PROTECTION

Good hydrant protection is important. There should be a good supply of fire hose, play pipes, etc., near the buildings. Stand pipes with hose connections on each floor supplied by public water mains are desirable. A good supply of approved chemical extinguishers and fire pails should be distributed throughout the plant. A standard automatic sprinkler system with adequate water supplies is recommended, particularly if the buildings are not of fire-resistive construction. Approved watchman's service should be maintained nights, Sundays and holidays and other days when not running.

FIRE REPORT

The National Fire Protection Association reports the total number of fires 407, as follows:

Cause	Number	Per cent
Ovens	104	25.6
Unknown causes	70	16.0
Ignition of grease	52	12.8
Matches—smoking	38	10.6
Heating	34	8.4
Chimneys and flues	25	6.1
Lighting	17	4.2
Spontaneous ignition	14	3.4
Rubbish	12	2.9
Miscellaneous	12	2.9
Defective electric wiring	7	1.7
Exposure	6	1.5
Power	6	1.5
Sparks from chimney	4	1.0
Bread wrapping machines	3	0.7
Incendiary	3	0.7
	407	100.0

ANALYSIS OF LOSS

	Sprinklered	Unsprinklered	Total	Per cent
Loss less $1,000	85	195	280	68.8
Loss more $1,000	6	121	127	31.2
Total	91	316	407	100.0

*Reference—Underwriters' Bureau of New England Report 166.

CLOTHING INDUSTRY

Hazards Simple But Important—Smoking, Pressing Irons, Waste Clippings and Rubbish Main Causes of Fire

By G. E. Lewis, Engineer, Fred S. James & Co., New York

The clothing industry, if not the most important, is at least one of the most important industries we have. Man can do without many things, but he must have food to eat, clothes to wear and heat with which to generate energy.

Construction details need not be gone into except to say that you will find manufacturers of clothes in all sorts of buildings from the little fellow in his frame, one-story, small area shack to the largest concerns which are housed in entire buildings of modern fireproof construction. In New York City there are many garment workers, the majority occupying one or more lofts in fireproof loft buildings, and in those so-called brick ordinary construction. In my opinion, the most important detail of construction is that there be facilities for quick and easy exit (such as fireproof and smoke stair-towers), standard elevator shafts, and inside stair-wells of brick, concrete or terra-cotta. The next detail, and this applies especially to loft buildings, is that all communications between floors be properly protected. This includes besides stairways and elevators, dumbwaiter shafts, belt-holes, chutés, etc.

PROCESS OF MAKING

Garment workers make clothes in much the same manner as a certain manufacturer makes automobiles. Each individual laborer, or group of laborers have one particular part of a garment to make, be it sewing on buttons, attaching pockets, cutting pocket flaps, or what not. At the start, the cloth is cut to a pattern. In the cheaper clothes this is done by an electric cutter, which cuts several thicknesses of cloth at the same time, but in the high-priced grades cutting is done by hand. After cutting, the several pieces of cloth that will go to make up a single suit are collected together, and sent to the Trimming Department. Here the buttons, braid, linings, in fact, everything that goes into the making of a suit are attached to the cloth. From here the garment is sent to the Making Department, where it is sewed together and completely finished.

The garment now goes to the pressing room where again each step is standardized. One worker presses the collar,

another the shoulders, another the coat proper, and so on. It is then packed and shipped.

SMOKING SPECIAL HAZARD

The hazards found in the manufacturing of clothing are simple, but important. A very interesting study was made by the National Fire Protection Association, and the results published in their Quarterly for October, 1916. It appears that out of 580 fires the causes of which were known, 173 were undoubtedly caused by smoking. That is, this very common hazard was responsible for nearly 30 per cent of the fires of known causes. In fact, smoking is not a common hazard in the clothing industry, but a special hazard. All laws to the contrary, these workmen will smoke. Any foreman or manager will tell you that if he rigidly enforces the no smoking rule he cannot retain a certain percentage of his workmen. They will not work for a man who does not allow them to smoke. Those who do work for him will smoke when his back is turned, and throw their lighted cigarette into a basket of waste clippings if they anticipate discovery. In New York State, I believe that smoking is forbidden by the State Industrial Commission, and laws to that effect are on the statute books. In one fire, it developed that the foreman had been treating himself to a smoke after the plant had closed down for the day. Another fire occurred in a risk where smoking was permitted, and it was shown that the person who owned the lighted cigarette which caused the fire was evidently the assured's private watchman.

PRESSING IRONS

Next to smoking, one finds that 111 fires were due to pressing irons, of which 49 were electric, 48 gas-heated, 1 stove-heated, and 13 unclassified. Workmen will leave the gas or current turned on with the result that the iron sets fire to at the time of the fire but he did not notice the blocked door. The risk had a watchman who was making regular rounds whatever combustible material it comes in contact with. The remedy is, first, adequate supervision after the workmen leave for the day, and, second, to have all electric irons equipped with pilot lights, and to shut off the gas at the meter. But even these latter precautions are not "fool-proof," as shown in the case of two fires reported, one of which was caused by an electric iron setting fire to wood, although the foreman had noticed, before he left the room, that the pilot light was out. It had burned out, but the current remained on. In the second fire, a gas iron caused trouble, in spite of the fact that the gas had been shut off at the meter. The employee using it had neglected to set it down on the metal base provided for that purpose, and the heat remaining in the iron

had been sufficient to cause a fire. The present requirements of the New York Fire Insurance Exchange call for the covering of the tops of all pressing bucks, pressing tables, and the floors thereunder, with sheet metal of not less than No. 24 B. & S. gauge, the metal to be carried over the table edge and up underneath, and on the floor to extend beyond the table limits for two feet.

WASTE AND RUBBISH

Next to pressing, comes the hazard due to presence of waste clippings, rubbish and sweepings. These are responsible for 91 fires out of the 580 mentioned above. The answer is—better housekeeping. Clippings and rubbish of all descriptions should be swept up at least once a day by a man, or corps of men, whose sole work this is, and the accumulated material placed in well constructed metal lined bins with lids kept open (if kept open they must be) by a cord equipped with a fusible link.

One fire occurred in a risk where rags and paper were taken outside daily but on the day of the fire a blizzard prevented its removal. Fire broke out in the rag room. The fire door was found blocked open and could not be closed.

Sewing and cutting tables equipped with power machines present a hazard in that cuttings and waste material accumulate underneath and are ignited by hot bearings on the machines, throwing lighted cigarettes under the tables and so forth. Fire stops are usually placed under tables exceeding dimensions 4 ft. by 8 ft. They consist of vertical metal sheets placed at 4 ft. intervals. This is most important in sprinklered risks as fires under tables cannot be reached by the water from the sprinklers overhead.

In risks where volatiles such as gasoline and benzine are used in cleaning materials a distinct hazard is present. A small quantity of the fluid will be placed in bottles or other ordinary containers for use as required. They are easily knocked over, the liquid perhaps comes in contact with the flame of a gas iron and fire results. The remedy is to have all volatiles in safety cans of a type approved by Underwriters' Laboratories. In one fire a small tailor had his shop in a tenant risk, he being directly under a celluloid factory. He had only a gallon of gasoline, but had been cleaning many clothes. The gasoline vapor accumulated, caught fire and the blaze got upstairs into the celluloid. Luckily, the risk was equipped with sprinklers and they held the fire in check.

MISCELLANEOUS HAZARDS

The common causes of fires such as heating, lighting, power,

chimneys and flues, matches, oily materials, and so forth all play an important part in clothing manufactories. In one fire it developed that finished clothing had been closely packed around an unprotected electric light bulb on a shelf, concealed from view. The current, however, was shut off. On the morning of the fire an electrician turned the current on and this particular light was left burning. Cloth began to smoulder, and the odor attracted the attention of employees soon enough to extinguish the fire without much damage. If conditions had been reversed and current left on over night, a bad fire might have ensued. Another fire occurred when an electric light cord was allowed to remain in contact with a metal clothes rack on which were large piles of suits and coats. A short circuit ensued, fire started and nearly all garments were destroyed. In one risk where the employees were mostly women, a fire started which was caused by neglect on the part of an employee, which caused a short circuit in an electric motor on the floor of the building. The insulation blazed up, throwing out sparks which ignited nearby inflammable material. Rapid spread of fire to the other floors caused a panic and several lives were lost through suffocation and leaping from windows. A fire occurred in one clothing risk in a small room in the basement, which adjoined the boiler room, and the smoke flue passed through this small room. The room was used for miscellaneous storage of empty packing cases, paper, clippings and other rubbish, and, at the time of the fire, was packed full with accumulated material, although other parts of the building were cleaned regularly. A large part of the material was piled against a boiler flue that had a defective covering. The engineer started up the boilers one morning apparently unaware of the piles of rubbish in the adjoining room, nor of the defective flue. A short time later fire started near one of the defective places in the flue, a place where a portion of the asbestos covering had been knocked off by packing cases. Fortunately, sprinklers were in this room and two heads opened, extinguishing the fire. This case is cited simply to show the extreme importance of not allowing accumulations of waste material and rubbish not only in clothing factories, but in other risks as well.

CHARACTER OF LABOR

The question of properly safeguarding hazards is one, primarily, of co-operation between the employer and employee. A certain class of labor is employed in many of these risks that, to say the least, has not the best interests of their employer at heart. The reasons for this condition are outside the scope of this article, but the fact remains that co-

operation is not often obtained and the result is disastrous to the insurance companies.

In my opinion, the only worthwhile form of protection for risks of this class is automatic sprinklers. The nature of the material used makes for the rapid spread of fire, especially where the goods consist largely of cotton stuffs and where waste clippings are allowed to accumulate on the floors and under tables. Other things being equal, the sprinklers can always control and many times extinguish incipient fires. In these risks control of fire is of the utmost importance because of the panic feature involved. A fire controlled at the start is much less likely to cause a panic than one which the employees can easily see has gotten out of hand.

Water supplies for sprinklers must be adequate, and should be determined by the inspection department having jurisdiction. Standard equipments, installed according to the rules of the National Board, should only be considered. An additional inducement for an employer to equip his plant with sprinklers is the lowering of his insurance premium and the cost of installation is thereby paid for out of this saving in a comparatively short time. It is not unusual for a concern to effect a saving of two-thirds of their annual premiums after sprinklers are installed.

Standard equipments of inside protective appliances such as fire pails properly distributed, chemical extinguishers, and small hand-hose connected to vertical risers supplied from roof tanks or city mains are necessary in all risks.

Practically all clothing risks will be found inside the city limits which assures the underwriter of proper fire department facilities and city hydrants.

Adequate watchman service is of much importance. A competent man who is well instructed in the use of fire appliances and has his employer's interest at heart, should be employed in this position. Unfortunately, this type of man is very rare.

BAD RISK GENERALLY

From the standpoint of the underwriter, this class of risk is not good business. The loss ratio is too high, especially in multiple occupancy risks. Contract garment makers (a concern making clothes under contract for so many pieces), especially, are poor risks. Orders are accepted under contract and when one contract is finished there may be an idle period until the next contract is secured, the overhead charges continuing, however. If business is poor with a long period between contracts the temptation to have the insurance companies "buy the business" is very great.

The class of labor employed is usually not of the best. Many foreigners are found who are very ignorant and unable to speak the English language. They work at top speed when their work is paid for by the piece, intent only upon doing as much work as possible in a given time, and oblivious to all else.

Cleanliness is not always good, except in the higher grade establishments and there are many irresponsible firms organized to do just a certain job or contract which, when finished, is perhaps their last piece of work.

The old sweat-shop has gone due partly to public sentiment and partly to a realization on the part of the manufacturers that more efficient work can be done under improved working conditions.

Each risk presents its own problem, and so should be carefully scrutinized by the underwriter before acceptance is decided upon. Some companies prohibit the class.

TOBACCO CURING AND MANUFACTURING RISKS

Processes From Drying to Selling, Warehousing and Conversion Into Finished Products; Cigar and Cigarette Hazards

By Ernest Kronimus, Agency Supervisor, Home Insurance Company, Before Insurance Society of New York.

Tobacco, grown perhaps in more widely-scattered areas than any other commercial plant, requires by reason of that, the

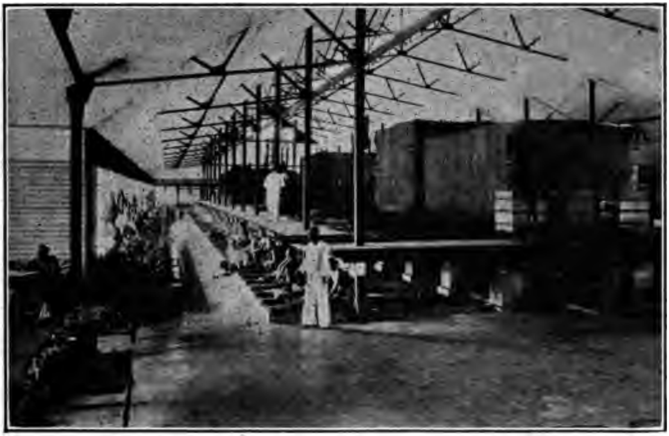


Photo by Underwood & Underwood

INTERIOR OF TOBACCO BARN

large number of varieties grown and different purposes to which it is put, various methods of curing, marketing and manufacturing, to prepare it for consumption.

In this paper an effort will be made to give a comprehensive though brief description of the several processes through which the leaf passes.

After harvesting the first step is curing. There are three essentially different methods employed in the curing of tobacco:

1. Air curing in which little or no artificial heat is used.

2. Flue curing, in which the tobacco is entirely cured by artificial heat and in such a manner as to prevent smoke from coming into direct contact with the leaf.

3. Fire curing, in which the tobacco is cured by artificial heat furnished by open fires, thus allowing smoke to come in contact with the leaf.

The method employed depends upon the variety and use to which the tobacco is to be put.

Cigar tobacco is as rule air cured.

Barns for this purpose are usually constructed 30 to 40 feet wide and often 300 or more feet in length. By reason of the enormous weight of the green tobacco strong, substantial construction is required. The green tobacco generally with the leaves attached to the stalk, except in cases of the better grade of wrapper tobacco, is hung on poles and placed in the barn, the usual practice being three tiers high.

METHODS OF CURING

Air curing, when that method is employed exclusively, involves no special hazard, but it is not always depended upon to bring about the desired results, and artificial heat, particularly in cold and wet weather, is resorted to. This of course involves considerable additional hazard. Heat is obtained from stoves and sometimes open fires of wood or charcoal. Where artificial heat is used intermittently, apparatus is very frequently not properly installed, and carelessness in safe-guarding the hazards is often met with.

After curing, which requires from 5 to 8 weeks, stripping is frequently done, particularly in the Connecticut valley, where the best grades of wrapper tobacco are grown.

As this is done in the fall of the year, artificial heat is required to heat the building properly, and all too often heating apparatus is not properly installed and the hazards carelessly guarded or more often utterly disregarded.

In the Virginia and Carolina fields, producing a leaf which after curing is of a bright yellow color and used for pipe and cigarette tobacco, flue curing is almost universally used.

Barns used for curing tobacco in this manner are built of logs or of framed construction. Where logs are used the cracks are closed with mud or mortar to make the structure as tight as possible.

The framed barn is constructed of timber framing sheathed inside and out with building paper between and with hip roof. Barns of this type are generally free from cracks but if any develop they are battened with thin strips of boards.

Ventilation is secured by means of roof ventilators or by cutting small windows in the gable ends near the roof which can be opened or closed as desired.

The heating system consists of a series of sheet iron flues leading from small furnaces at one end of the barn which are fired from the outside.

Unlike cigar tobacco the leaves as they mature, are cut from the plant—several bunched together in what is known as a "hand," fastened on poles and hung in the barn.

After the barn is filled completely, it being desirable to do this in one day, small fires are started in the furnace and a moderate temperature maintained for a period of 24 to 36 hours or until the leaf is thoroughly yellowed. The temperature at the completion of this step is about 120 degrees and this process is called "fixing the color." The heat is now gradually increased up to approximately 140 degrees or until the leaf is thoroughly dried out; this step requiring from 10 to 18 hours after completion of the yellowing process. Ventilators are now closed almost entirely and the temperature increased at the rate of about 5 degrees an hour, sometimes to as high as 200 degrees or more, which is maintained until the stems are completely dried out. The entire process requiring from three to four days.

SOME FIRE DANGERS

It will be readily seen that this method of curing involves severe fire hazards. Defective construction of the flues, flues too close to woodwork, the possibility of tobacco falling on or otherwise coming into contact with the flues are some of the dangers. Carelessness in attendance at the fires also constitutes a severe hazard. Extreme caution should be exercised in employing trustworthy help to look after the firing. It is also important that accurate thermometers be secured. During the war period these were rather difficult to obtain and at least one field man representing a company writing a large volume of this business is of the opinion that numerous fires were caused by defective thermometers.

The third method of curing by open fires is largely confined to those sections growing the export grades of tobacco, namely; central portion of Virginia, parts of Maryland, Kentucky and Tennessee and along the Ohio-West Virginia line. Barns used for this type of curing are usually smaller in size although high enough to contain five sets of tiers. They are generally constructed of logs although in recent years framed buildings have been erected.

During the early stages of curing no heat is employed. After the tobacco has been hanging three to five days slow fires are started and a temperature of about 90 degrees maintained until

the yellowing of the leaf has been completed. The temperature is then gradually increased until it reaches 125 or 130 degrees. All told the fires are kept up 3 to 5 days.

The hazards incident to this method of curing are more serious than any of the others. Fires are sometimes built on the floor level and the danger of sparks blowing up between the tobacco is very great. A safer method, if the word safe may be employed in connection with fire curing, is to build fires in pits with wire mesh to prevent escape of sparks.

Ample clearance should be allowed between the fire and the lower tier of tobacco. Extreme care and constant attention is necessary at all times in this type of barn.

CURING BURLEY

The Burley crop, most of which is grown in Kentucky, is cured without the use of much artificial heat. The entire stalk is hung and the process is somewhat like the curing of cigar tobacco. Burley is manufactured into chewing tobacco because it very readily assimilates flavoring extracts.

In some parts of Virginia a type of tobacco is produced which is known as "sun cured." The tobacco hung on sticks is crowded very closely together on a scaffold near the barn. After yellowing or in about from 4 to 6 days the sticks are spread farther apart and left on the scaffold a few days longer. The curing is then completed in the barn. This tobacco is used mainly for chewing purposes.

After curing the tobacco is ready for the market and here also, different methods in the several fields obtain.

SALES WAREHOUSE HAZARDS

In the Connecticut field the entire crop of a farm is sold to buyers right on the ground except where stripping is done, and in those cases the tobacco is boxed and shipped to manufacturing centers.

Burley tobacco is graded and packed into hogsheads and sold by sample taken therefrom. In recent years however it is becoming more and more the practice to sell by the loose leaf auction system in vogue in the Carolinas.

In the Carolinas the tobacco is carefully sorted into various grades by the grower and brought to the sales warehouse where auction sales are held at regular stated days and hours.

Sales warehouses are generally of large area and in cases of older buildings are of frame construction. In recent years, however, numbers of substantial brick buildings have been erected. Regardless of the material used in the walls concrete floors are of decided advantage over wooden.

The grower usually drives in with his tobacco the day before the sale, camps right there and then, actually sleeping on the

crop. This of course involves some hazard; among other things the farmer proceeds to puff away on a corn cob pipe, not paying much attention to the number of unused matches he drops or whether or not the match used in lighting the pipe is thoroughly extinguished before it is discarded.

In addition the stabling of the horses is an added hazard. While formerly horses were frequently housed right in the warehouse, necessitating the storing of hay and other fodder, this practice is being largely discontinued. In large numbers of instances however stables adjoin and badly expose the warehouse proper.

PACKING METHODS

The manufacturer, through his agent, is usually the buyer at these sales and the tobacco now enters the first stage of manufacture.

Tobacco, in order to keep without rotting when packed into hogsheads or other container, must first be dried of its content of sap, gum, oils, etc.

Here also we find different methods employed for the handling of the several types of tobacco and we will first consider cigarette and pipe tobacco, representing the larger proportion of the crop.

Two methods are in the main in use for drying tobacco of this type.

1. "Conveyor" machines through which the leaf is conveyed while being dried, cooled and ordered.
2. "Truck" dry rooms into which truck loads of tobacco are wheeled, there to remain under artificial heat until in order.

As the "Proctor" conveyor machine manufactured by the Philadelphia Textile Machinery Co. is most largely if not universally used, we will limit ourselves to a description of that machine.

The older type of dryer was generally constructed of wood Here also we find improvements made in recent years in the matter of safer construction. The newer type of machine is of all metal construction, with the exception of the ordering compartment which is normally constructed of wood but divided into compartments by metal partitions. These machines are of three types: The "Apron"; the "Stick"; the combination "Stick and Apron."

The machines are of varying length from 30 to as much as 300 feet, from 10 to 18 feet wide and ordinarily 8 to 10 feet high.

In the "Apron" machine the tobacco is spread out on a moving belt called the apron. The "Stick" machine is limited to drying leaf in "bundles" or in "hands," the tobacco being straddled across the sticks, and conveyed through the machine in that manner. The "combination" is, as the name implies, a combination of the two and is most frequently in use.

The apparatus is divided into three sections, namely: drying, cooling and ordering. The drying and ordering sections are in turn divided into from two to five sections each, separated by wooden or metal partitions depending on the general construction of the machine, with openings just large enough to allow the passage of the tobacco. Heat is furnished by steam pipes arranged in coils at each side of the heating section and is evenly distributed by large fans.

The tobacco is conveyed successively through the heating compartment at a temperature of from 150 to 200 degrees to thoroughly dry, thence through the cooling compartment where a temperature of approximately 110 degrees is maintained and from there through the ordering section. In this section the tobacco receives a given amount of steam and water spray, also distributed by fans and is now said to be "in order." From 30 minutes to one hour and a half is consumed by the tobacco in passing through.

There is nothing specially hazardous in drying tobacco by this process in so far as the leaf or the machine is concerned, but there is considerable danger from the presence of foreign material, particularly matches, rags, paper or other inflammable trash. This danger is more marked when scrap tobacco is being dried in which is included the sweepings of warehouses and factories. With proper attention given to bearings the danger of fire from that source is light.

EQUIPMENT OF DRYERS

Dryers should be, and as a rule are, equipped with automatic sprinklers inside of the machines fused at 286 degrees. In addition each compartment should be equipped with steam jets. Construction of the machines on an incline sufficient to drain water to outside of building is a desirable feature.

Truck dry rooms are not often met with. The room consists of an enclosure constructed of matched boards and divided into two lateral sections by a horizontal partition about 7 feet above the floor. The upper section is equipped with steam coils and fans to properly distribute the heat and in the lower, trucks loaded with tobacco for drying, are placed.

Temperature of from 150 to 160 degrees are maintained. After drying the leaf is placed in similarly constructed ordering rooms but in these no heat is maintained, the tobacco only moistened by steam and water. These devices are more hazardous than the patented Proctor dryer, described above, but as stated are not often met with. After drying and ordering the tobacco is "prized." "Prizing" is packing in hogsheads under hydraulic or other pressure.

This process in itself involves no special hazards but there are incidental hazards, notably coopering. Cooper shops should be

located in separate, entirely detached buildings and in modern plants this is usually the case. After prizing the tobacco is stored for several years to age properly.

Perhaps the most important element to be considered in tobacco factories is good housekeeping. This involves of course care in storing and handling lubricating oils, the main supply of which should be kept in an outside building only one day's supply to be brought into the main building.

Self closing metal cans provided for oily waste which should be disposed of by burning under the boilers and under proper supervision. Shafting and bearings should be looked after carefully by a man assigned for that purpose; smoking and carrying matches prohibited; fire apparatus regularly cared for.

Lighting should be preferably by incandescent electric lamps. the equipment of course installed in accordance with National Board standards. The boiler should be set properly with ample clearance between top and ceiling; preferably cut off from the plant.

Heating should be by properly installed steam plant, steam pipes well supported and kept free of combustible material. It may be well at this point to briefly consider the inherent hazard in the tobacco leaf itself.

Fermentation takes place in practically all forms of tobacco and in varying degree. This action may or may not cause fire in the material itself but when heated to a considerable degree and in the event that the tobacco comes in contact with a combustible material such as wood this heating might carbonize it to such an extent that fire would result. It seems to be the general belief however that fire danger from that source is rather remote.

Some tobacco men incline to the belief that if imperfectly dried or not properly ordered spontaneous heating is likely to occur. Others contend that heating results from too high "order" alone and not from drying. There is said to be a case on record where a hogshead of tobacco after being on storage for several years, was found upon opening to be a charred mass. In one or two other instances it is recorded that heaps of tobacco when turned over were found to be smouldering.

As tobacco is very closely watched, for the reason that over heating would ruin the leaf even if fermentation did not ensue, the likelihood of fire from overheating is small.

AGING IN STOREHOUSE

From the prizery the tobacco is transferred to storage warehouses there to remain until it is aged, requiring in some instances as long as two years.

The storage of tobacco involves no special hazards, warehouses as a rule being occupied for that purpose exclusively.

Housekeeping in risks of this class should be of the best. Stabling and camping should not be permitted under any circumstances. Lighting should be by electricity installed properly with wires in conduit. Heating is not necessary. Large numbers of warehouses built expressly for that purpose are to be found in the tobacco districts and they are considered excellent fire risks. After aging the tobacco is ready to be manufactured into its various forms.

The manufacture of cigarettes has been revolutionized in recent years. Machines are employed largely, if not entirely. A modern cigarette factory represents high attainments of mechanical skill and ingenuity.

After opening the hogsheads the tobacco is generally "sweated" and "cased." Casing is the addition of flavoring extracts such as licorice, sugar, etc. Glycerine is also used in this part of the process. The leaf is now sliced into "long cut" or "fine cut" as required in machines especially adapted for the purpose. The tobacco is then dried and cooled in a special type of drying machine which also loosens the shreds and makes the stock light and fluffy. After this process the tobacco is ready for the cigarette machine.

These machines have reached a very high degree of efficiency and speed, being capable of turning out 400 finished cigarettes a minute. The output of one concern manufacturing a widely advertised brand is 100,000,000 a day in its several factories.

CIGARETTE FACTORY

A large number of incidental hazards are found in a modern cigarette factory: machines for wrapping the paper and the foil around the finished product; kettles in which flavoring liquors are prepared are generally steam jacketed and as a rule safely installed.

The industry is more or less confined to a limited number of large companies amply financed and conducted in a very efficient manner.

The plants are very often housed in modern buildings equipped with automatic sprinklers and special hazards incident to the occupancy thoroughly understood and well protected.

Common hazard such as heating which is usually by steam, lighting as a rule by electricity and the hazards incidental to power transmission are generally safely guarded as well as the handling of lubricating oils.

Plants are generally in good condition as to care and cleanliness; oily waste properly disposed of, sweepings regularly removed, proper supervision given to shafting and bearings and fire apparatus regularly looked after.

CIGAR MAKING HAZARD LIGHT

Unlike the manufacture of cigarettes, cigars, particularly the

better grades are hand made in some instances with the aid of molds to set and form the fillers, in other cases by hand exclusively. There are no special hazards involved in cigar making.

The tobacco is sweated to enable it to be handled more readily: "cased," that is, flavoring extracts added, stripped by hand and then made into cigars, packed and shipped. As no power is used common hazards are confined to heating, lighting and general housekeeping. It seems however to be the usual practice to permit smoking in plants of this character, particularly in the South and there is of course a certain amount of hazard from that source. Small cigars, cheroots, stogies and the cheaper grades of large cigars are machine made. No special hazards of note are involved. The first operation is the making of "bunches." Filler strips are run through a machine which "bunches" them and rolls them into shape after which they are placed in moulds and pressed. The bunches are then trimmed and run through a machine which cuts the wrapper, rolls and pastes it around the filler.

In the larger cigar factories, incidental hazards such as wood and paper box making, printing of wrappers and machine shop are met with. These of course are subject to those safeguards peculiar to each, the discussion of which would hardly come within the scope of this paper.

Chewing tobacco is generally prepared after the manner described for the preparation of cigarette and pipe tobacco, that is drying and prizing. Some factories receive the tobacco from warehouse after it has aged; in others it is received from sales warehouses, rehandled, dried, prized and stored in warehouse for ageing. The cutting of leaf and pressing into forms or the manufacture of twist leaf does not involve any particular processes or special hazards worthy of note.

MAKING SNUFF

The manufacture of snuff is a rather complicated process. "Lugs" as the lower leaves of the tobacco plant are called and which are of a poorer quality along with other lower grades and sometimes sweepings are used.

After aging for several years the leaves are cut up—not fine but rather coarsely—then reordered and reprized into the hogsheads in order to permit it to ferment or sweat. This process is repeated several times before the tobacco is ready for the next step. It is then toasted in a cylindrical revolving dryer or shaken in a series of trays in a highly heated room. The tobacco is now ground or pulverized in machines known as mulls. The snuff is now cleaned in a machine known as a bolting reel and is ready for packing. While the process is rather complicated there are no special hazards of moment.

PACKING AND LABELLING

Ordinary common hazards are of course met with and in addition to the hazards incident to the manufacture of the finished article. Incidental hazards such as packing and labelling are of course found and in some of the larger plants a small amount of wood working in connection with box making is done.

The entire tobacco industry is fraught and beset with countless difficulties to be overcome. The growing requires a high degree of skill. Unlike most crops, where after harvesting the grower's troubles are practically at an end, the tobacco grower's troubles may be said to have only begun. A fine harvest can be ruined in the curing process. Although the processes of curing tobacco may appear to be, and have been described as being, in a crude state as compared with the manufacturing branch of the industry, the present methods are nevertheless the only known ones and only experienced men specializing in that type of employment can hope to make a success.

This fact calls for greater vigilance on the part of the underwriter in accepting risks of the class not only from the standpoint of physical hazards involved but from moral hazard as well.

In addition to moral hazard in individual cases, for reason as above indicated, that element prevails to a greater or less extent in some branches of the industry and is more pronounced in the growing districts particularly where the leaf is grown to the practical exclusion of all other crops.

A material reduction in the yield or grade or over production, or lack of demand, all tending to cause a fall in price will tend to bring about moral hazard.

A condition such as this will not alone have a direct affect on the tobacco industry but has in the past and will likely again in the future materially affect the entire mercantile activities of a given district.

This condition is not likely to be met with in the cigarette making industry as those in control of that branch of the business are really the dominating factors in the business at least in the Southern territory and being the buyers they naturally are an important element in the matter of price.

The cigar making industry has in the past been subject to labor disputes of a more or less serious character and it is believed that some fires in the Tampa, Florida, district several years ago were of incendiary origin as a result of such labor difficulties.

All in all the industry by reason of its many ramifications, the large values involved and its recognized importance, is worthy of deep study on the part of every underwriter.

HOTELS

Fine Fireproof Types in Cities; Danger of Furred Walls; Defective Chimney Cause of Most Fires; Overloaded Wires and Laundry Equipment

By G. E. Lewis, Erginceer, Fred S. James & Co., New York

This article will divide the subject into three parts to cover: (1) Construction, (2) Hazards, and (3) Protection.

There are HOTELS, HOTELS and hotels, ranging all the way from the magnificent fireproof edifices of our own New York down to the little two-story ramshackle frame buildings that are a part of most small towns. Perhaps I ought to say "that *used* to be a part" of every small town, for I believe that under the Eighteenth Amendment the village hotel will gradually cease to be.

Excellent examples of fire-proof construction are found in all the larger cities. The Plaza, Biltmore, Ritz-Carlton and McAlpin in New York; the LaSalle, Sherman and Blackstone in Chicago; the Ritz-Carlton and Bellevue-Stratford in Philadelphia, are all of superior fireproof construction. However, this type is in the minority due, of course, to the heavy initial cost, which necessitates a large return to make the investment profitable.

Fireproof construction, as applied to hotels, is not any different essentially than the same construction in an office building or a manufacturing loft. However, each guest room should constitute an individual fire unit separated from adjacent rooms by fireproof walls or partitions. Where it is necessary to have rooms en suite the doors should be of metal. Floors should be of concrete or similar fireproof construction, and where the laying of carpets is a feature a small wood nailing strip can be set in the cement floor. Window casings and door frames, together with all other trim should be of pressed metal. If this is impracticable then very hard wood should be used. Needless to say, all openings from floor to floor should be enclosed in brick, concrete, or tile shafts with doorways protected by labelled, automatic fire doors. This is important, and if you will only become convinced and realize that floor openings should be protected you will have gained a lot. One of the first things a person learns in life is that fire is carried along by a draft. Those of you who have not lived all your lives in apartments can remember some member of the family going

down cellar to "tend to the drafts of the furnace," and I have reached the conclusion, after inspecting a good many buildings, that the lesson learned alongside the old furnace and the cookstove has been thoroughly assimilated by that portion of mankind directly connected with the erection of buildings because wonderful and fearful are the methods used to promote and maintain drafts so that if once a building does catch fire it becomes a veritable furnace. But more of this later.

MOST ORDINARY TYPE

The commonest type of hotel construction in our cities is the so-called ordinary, or non-fireproof type. Walls are of brick and when built will usually conform to existing city ordinances. However, changes and additions will often so alter the function of the original walls that careful investigation is necessary. For instance, where additional stories have been added the bearing walls below these added stories will not be of sufficient thickness to carry the extra load. Sometimes columns will be bolted to the walls of the lower stories and a light steel frame inserted to carry the load of the upper stories. Such construction as this will make the building a house of cards that will come down in any ordinary fire perhaps not waiting for the fire if the load becomes too great.

In hotel buildings of ordinary construction, look out for furred walls. A small wood strip is attached directly to the wall, and the lathing is nailed on this strip, thereby forming an air-space between the brick and the lath. This air space forms an excellent flue through which fire communicates from one floor to another with remarkable rapidity. Fire located back of the furring is very difficult to fight. Where furring is necessary, a cheap fire stop can be effected by ordinary wet mortar, filled in between the studding. The building code of some cities provides that if furring is to be used the course of brick above the under side and below the upper surface of each tier of floor beams must project out from the wall the thickness of the furring. This provides a good fire stop.

OPEN ELEVATOR WELLS

Floors are usually of joisted construction with single layer of matched boards on the joists and the ceiling below constructed of lath nailed to the under edge of the joist and then plastered over. Where deadening is desired, the space between joists is partly filled with grout. Double flooring is sometimes found in main hallways, dining rooms, lobbies and the offices. Tile is often found on the first floor in the lobby. Stairways are usually open, as are also the elevator wells. This should not be. In every hotel whatever, no matter what the construction, there ought to be adequate provision for the prevention of fire spread-

ing from floor to floor. A large majority of hotel fires have been turned into total losses, with terrible loss of life, because fire could spread rapidly from floor to floor. Stairways, elevator wells, vents, dumbwaiter shafts, pipe and wire ducts should all be enclosed in either brick, concrete or tile shafts with standard fire doors at all door openings. If windows are really necessary in a shaft they should be approved wire glass set in metal frames. The ideal arrangement would be to have all stairways and elevators in outside towers with door openings at each floor protected by fire doors, but this condition is usually not possible. The construction of the so-called grand stairway leading from the first to the second floor should be discouraged. Fire will travel up it much more rapidly than the bell hop will.

In addition to the ordinary floor openings found in any building, a hotel has several others, such as ventilator shafts, service chutes for linen, back stairways for employees and freight elevators. Ventilation shafts will transmit smoke and fire very rapidly. The system is equipped with two fans, one used as a blower, installed in the basement, that draws in the air, blows it over steam coils and thence through the ventilating shaft to the rooms, and the other a suction fan located on the roof, which sucks the vitiated air from the rooms.

FRAME HOTEL BUILDING

Little comment is necessary. You all know them. Big, frame barn-like affairs the majority are. Usually constructed of ornamental, flimsy material having large areas with no cut-offs. When a fire starts in one of them it gains headway very rapidly, often times not giving the guests time enough to escape with their lives, to say nothing of their personal effects. In this class the area should be reduced as much as possible by building in sections with each section cut off by a brick fire wall all door openings in which being protected by standard fire doors. Avoid mansard roofs, they will spread fire rapidly. Shingle roofs are bad especially on porticos, piazzas, etc., where guests can flip a cigarette onto the shingles from an upper window. All roofs should be either of metal, tile, slate or other approved material. A blazing brand from an exposure fire has ignited many a shingle roof.

HAZARDS

I have touched lightly the subject of construction, for hazard is of more importance to you, I believe, and perhaps we can go into this phase of the subject in more detail.

From a list of nearly sixteen thousand hotel fires covering a period of several years, we find that about 25% of them are caused from exposure to burning property, about 25% are due to unknown causes, 17% from defective flues, 8% from incendiaries

and the balance are caused by stoves, lamp explosions, matches, cigar stubs, sparks, defective wiring, gas jets, furnaces, stove pipes and spontaneous combustion.

The Bureau of Fire Prevention and Public Safety of Chicago has tabulated the causes of hotel fires occurring in 1916, 1917, 1918 and 1919. Out of 166 fires, they have found that 41 were caused by smoking in bed, 36 from gas jets, 23 from careless use or disposition of lighted cigars and cigarettes, 22 from ranges and ventilating systems, 11 from heating plants, 11 from gas plates, 9 from defective wiring, 7 from unknown causes, and six were caused by inflammables used in disinfecting.

In the report issued by the Indiana State Fire Marshal covering 1917, 1918, we find a total of 66 fires. The value of the property involved was $2,537,845 (buildings and contents) and the estimated loss to buildings was $140,281, and to the contents $59,375. The causes of these fires are all included in the list previously mentioned, except one fire caused by a chemical explosion and one caused by lightning.

Elimination of the exposure hazard is impossible, unless the building is completely isolated, but the reduction of this hazard is possible by using approved roof coverings, wire-glass windows, standard fire shutters, and the doing away with highly ornamental frame exteriors that are so apt to become ignited. Adequate public (or private) hydrant protection is an important factor in preventing fires from exposure together with an efficient force of fire fighters to handle the apparatus.

WORST FIRE HAZARD

The worst single cause of fires in the United States is the defective chimney together with improper flue and stove pipe connections. The combination of defective chimneys and wooden shingle roofs causes more trouble, both inside and outside of the fire insurance fraternity than any other one thing. Hotels are no exception. There are countless numbers of hotels in the smaller towns where this combination exists and sooner or later fire is going to occur. I should like to refer to this subject at some length, but if you will go to the Insurance Society's library and obtain the copy of Dwelling Houses, a booklet issued by the N. P. F. A., you will find therein on pages 50-64 a very complete account of chimneys, their use and abuse, together with interesting photographs and diagrams showing proper construction. About all I can say here is that chimneys should be built from the ground up (never resting on or supported by rafters or floor beams), should be at least 8″ thick, should be carried 2′ or 3′ above the roof, and should be entirely free from contact with any wooden construction.

A number of hotel fires are caused by incendiarism. Probably a majority of these are due to a moral hazard invested in

the owner. Hotels in small towns and villages are not any longer a paying proposition. I believe, and while it is difficult to conceive of an owner setting fire to property in which human beings are housed, it has been done. Then, too, where one's money is tied up in a poorly paying business a proper degree of carefulness is not observed, in fact a decided degree of carelessness is very evident. Many hotels have now been deprived of income from the selling of liquor, and it is doubtful whether they can make this up. It remains to be seen whether this will have any influence on the number of fires in the future.

Smoking in bed is undoubtedly responsible for many fires. Unfortunately, it cannot be prevented. The best the proprietor can do is to post signs in all rooms forbidding it. The same holds true for the throwing of lighted cigars and cigarettes in waste paper baskets. Provide metal baskets and trust to the quickness of the guest to get it out of the window if a fire starts in one. In that case you may have a loss under your public liability policies if the sidewalk is crowded and the guest is a good shot.

The blowing of curtains against gas flames has caused fires, as has also the proximity to combustible material. These gas jets should never be near curtain hangings but often they are. Burners should be over 6" from the walls and 3' from ceilings unless a metal bell is suspended between the flame and the ceiling when the distance may be reduced to 18". Swinging brackets should never be allowed.

COUNTRY HOTELS

The old fashioned kerosene oil lamp is still used for lighting in a large number of country hotels. They are safe enough until one is knocked over by a careless guest or servant. Explosions will sometimes occur if the oil supply is permitted to become exhausted. The intense heat from the wick will generate combustible and explosive gases from the small remaining amount of oil in the lamp reservoir until an explosion takes place. The remedy is to keep the reservoir well filled at all times.

In many small hotels the kerosene lamp is superseded by acetylene gas or gasoline vapor. The acetylene generator is simply an arrangement whereby water is mixed with calcium carbide, acetylene gas resulting from this mixture. The gas is highly explosive when mixed with air in the right proportion. Approved devices should only be installed and the generator should always be in a separate building. Calcium carbide should be kept in metal cans and stored in a dry place. Gasoline vapor for lighting is generated in much the same way as in the automobile, by machines having inside or outside carburetors; systems having outside tanks and inside flame heated generators,

and so forth. The minimum amount of gasoline should be used. All installations of both acetylene and gasoline vapor systems should be in accordance with the rules of the National Board. Permission for their use should be granted by endorsement on the policy.

OVERLOADED WIRES

The remedy for defective wiring is to have the original installation made in accordance with the N. E. C. and the rules of the code should govern all additions to the equipment. A large number of fires, the causes of which cannot be accurately determined, are probably due to defective wiring. Additional electrical devices are connected to the system causing a heavy overload and some guests will do ironing, hair curling, light cooking and water-heating by electricity in their rooms. An electric iron left on a wood table or ironing board will burn through in a comparatively short time.

Heating hazards occur in the kitchen, bakery and boiler room. In the kitchen and bakery large ovens and stoves are found. These should be set on a brick or concrete base (with separate foundations for them) extending four feet on all sides from the base of the oven. No woodwork or other combustible material should be permitted either under, over or around a stove or oven. No range or oven should ever be installed over wood floor beams no matter what may be placed between the stove and the beam. Heat will travel through courses of brick and in time ignite the wood. A case is on record where the heat from the base of a hotel range set fire to timbers underneath in spite of the fact that there was 5″ of concrete between the bottom of the range and the top of the timber. An air space between the range and the incombustible base shows good design, but the floor must be of fireproof construction in all cases. Boilers should be set in brick, well insulated, set on concrete floor, and contained in a separate room, as under the sidewalk, and cut off from the rest of the building by a 12″ wall with standard automatic fire doors at all openings. The enclosure should be thoroughly fireproof.

When heat is furnished by the ordinary furnace, it should be set on a concrete or earth floor with 48″ clearance to any woodwork. All the rubbish and accumulations of combustible material usually found in cellars and small town hotels should be kept away from the furnace if it is not possible to remove it entirely. Ashes should be placed in metal cans, never in wooden boxes or barrels. The ordinary coal stove is used in village hotels, and about the only protection provided is a sheet of metal on the floor beneath it, and an air space if the stove is set upon legs. Sometimes a sheet of metal is nailed on the wall behind the stove.

LAUNDRY EQUIPMENT

Our large city hotels are equipped with a laundry. This presents no serious hazard if installation of such heating devices as dryers, mangles, irons and the like are properly made. All gas connections should be of rigid pipe and never of rubber tube. Pressing and ironing should be done on metal covered tables and the floor beneath the table should be metal covered. Dry rooms should be fireproof, with all steam pipes installed in a vertical position and protected by wire screen placed 2" from the pipes. In the larger cities laws will govern the installation and protection of the major heating hazards, but, even so, supervision by the insurance inspection and rating bureaus is advisable.

The modern hotel, as seen in our larger cities, is really a little community in itself. Such a large number of hazards are presented that I cannot present in detail here. Among those that will be found are carpenter shops, painting hazards, furniture repair rooms, upholstering departmens, plumbing, printing, tailoring shops with their attendant pressing hazards, store rooms and so forth. Supplies are bought in large quantities, among which will be found oils, varnishes, paints and lacquers; gasoline, benzine and other volatiles; excelsior and large quantities of paper. Oils, paints and varnishes should be in a fire-proof vault preferably outside the building. Volatiles should be used in small quantities from approved safety cans with the main supply tank underground.

Housekeeping is an important feature in hotels as it is elsewhere. Accumulations of paper, rubbish and other sweepings should never be allowed. As soon as the day's allotment is collected, it should be placed in metal cans and removed from the building. Excelsior and similar material must be stored in standard packing cases that are lined with lock-joint tin.

AMMONIUM NITRATE

Exploded Only by Detonation and Then Only by Using As a Detonator Some High Explosive—Ordinary Warehouse Explosion Hazard Negligible

By A. M. Schoen, Chief Engineer, South Eastern Underwriters' Association

Ammonium nitrate is the subject of a special bulletin by A. M. Schoen, chief engineer of the South-Eastern Under-

Underwood & Underwood

THIS AIRPLANE PHOTO WAS TAKEN THE SECOND DAY AFTER THE EXPLOSION, WHICH COMPLETELY WRECKED THE BADISCHE ANILIN WORKS AT OPPAU, GERMANY, KILLING HUNDREDS OF WORKMEN. THE IMMENSE HOLE WHERE ONCE THE GASOMETERS STOOD IS SHOWN IN THE FOREGROUND

writers Association, Atlanta, in which the explosions and fires at Morgan, N. J., in the steamship *Hallfried* and in the Badische Anilin und Soda Fabrik at Oppau, Germany, are used as examples. This report reads in part:

Ammonium nitrate is a salt prepared by neutralizing nitric acid with ammonia gas or ammonia liquor or by double decomposition between sodium nitrate and ammonium sulphate.

PROPERTIES

Ammonium nitrate is crystalline or granular in its structure, white when pure, but usually of a light brown color. It is highly deliquescent and if left exposed to the air will absorb moisture rapidly. It is an inorganic, incombustible salt, but in contact with incandescent organic matter releases oxygen freely and when subjected to moderately high temperatures gives off oxygen very lightly combined with nitrogen as N_2O or nitrous oxide gas. It is exothermic, that is, liberates heat when undergoing decomposition. In 1883 Bethelot showed that if heated rapidly enough it would decompose with explosive violence, giving off under the reaction nitrogen gas, water and free oxygen.

Ammonium nitrate is a synthetic compound, that is, a laboratory product, and is used principally for making high explosives and in the manufacture of fertilizer.

FIRES AND EXPLOSIONS

The fire and explosion at Morgan occurred October 14, 1918, shortly before the cessation of hostilities in the World War, and while the T. A. Gillespie plant was in full operation making munitions. The report of a chemist engaged in the manufacture of high explosives, who visited the plant after the explosion, recites that he found several piles of ammonium nitrate lying on the ground where the storage houses for this material had formerly stood. These piles were 15 or 20 feet in diameter and 5 or 6 feet high, and contained many blocks of ammonium nitrate roughly the shape of a barrel. Of these piles it was quite evident that none had undergone explosion, but that they had simply burned until all of the organic matter contained in them was consumed, which was, of course, accompanied by proportionate decomposition and loss in the nitrate. It appears there were several heavy explosions, some of which were said to be ammonium nitrate though it was not ascertained whether it was pure ammonium nitrate or ammonium nitrate mixed with T. N. T. Throughout the fire, which lasted many hours, there was a continuous explosion of loaded shells and these were thrown in all directions to considerable distances from the plant, in some cases more than a mile. Later some of these shells exploded on handling, so it is quite conceivable that loaded shells might have been thrown into a burning building containing ammonium nitrate and then exploded on striking or subsequently from the heat.

STEAMSHIP FIRE

In the case of the steamship *Hallfried* fire alone occurred. This ship took fire while unloading at one of the Brooklyn piers on April 19, 1920. The cargo was a mixed one, consisting of raw skins, paper and ammonium nitrate in casks. It is thought the fire started from some chlorate said to have been on the boat. There were 8,460 casks of ammonium nitrate aboard and all of the casks which had not been unloaded from compartments 1 and 2 were destroyed, namely, 3,111, as well as 1,972 casks on lighters alongside the boat. None of the nitrate in No. 3 compartment was damaged. It is a fact worthy of note that there were only 30 or 40 casks partially damaged; in all other cases the casks were either completely destroyed or the contents were uninjured.

EXPLOSION IN GERMANY

The Oppau disaster occurred on September 21, 1921, at the plant of the Badische Anilin and Soda Fabrik and was caused by the sudden explosion of about 4,500 tons of ammonium sulphonitrate, a practically unknown chemical fertilizer. It was at first the general impression that ammonium nitrate alone had been responsible for this terrific explosion, but it is now well known that ammonium sulphate had been mixed with it. There were two explosions, the first at 7.29 A. M., followed three minutes later by a second, both of terrific violence. Dr. Ing. Carl Commentz in his article published in Chemical and Metallurgical Engineering says: "The large buildings containing the ammonium sulphonitrate disappeared entirely and nothing was left in their place except a mammoth crater 250 feet in diameter and more than 50 feet in depth." He states further that "430 lives were lost * * * and the village of Oppau, surrounding the plant on three sides and inhabited mostly by its workmen, suffered great damage. Over 70 per cent. of the thousand dwellings were either totally or partly wrecked." Damage was done to property as far as Heidelburg, 14 miles distant, and Frankfurt, 53 miles distant, while the shock was felt as far as Bayreuth, which was 145 miles from Oppau.

As all of the workmen in or near this part of the plant were killed, it has not been possible to ascertain what happened just preceding the explosion. It is known, however, that the material being stored in silos in bulk, it had been the practice to break up the piles by blasting with dynamite and also that a change in color and a rise in temperature of the mass had been noted the day before the explosion. Dr. Commentz calls attention to this and remarks that "This would appear to strengthen the suspicion that by some sort of a decomposition there had been a spontaneous ignition of

the mass." Had the material on storage, however, been pure ammonium nitrate without the sulphate, it is difficult to conceive of any chemical change or reaction that could have brought about these conditions. Referring to the mixed salt, Dr. Commentz quotes from the experiments reported by the director of the Physikalisch Technische Reichsanstalt as made with ammonium sulphonitrate in his institute directly after the catastrophe as follows: "A large number of unsuccessful attempts were made to explode this material, even with strong blasting dynamite cartridges, such as are commonly used for mining purposes. However, using a very strong initial explosive and with the material packed into iron piping, the institute succeeded in exploding a part, but not all, of the ammonium sulphonitrate. Fire and high temperature appear to have no exploding effect on this salt. The director concluded that nothing could be deduced from the experiments which might be said to have caused the explosion."

P. S.: Such ammonium nitrate explosives as masurite and nyalite were most insensitive to explosion by fire, and I believe that a carload of ammonium nitrate and nitro-glycerin explosive such as monobel has burned away quietly.

SHIPPING AND STORAGE

Owing to its strong affinity for water, ammonium nitrate must be protected against moisture to prevent loss through deliquescence, in consequence of which, instead of being bagged for shipment, as with sodium nitrate, it is put in well constructed, water-tight casks of 500-pound capacity each. The description of these casks is as follows: Height, 38⅜ inches; diameter ends, 28⅜ inches; staves, tongue and grooved, ¾-inch spruce, beech or birch, heads tongue and grooved, ⅝-inch, with ¾ x 1½-inch cleat on outside; hoops, 6 feet by 5 inches by 1/16-inch strap iron, with centers spaced 1½, 5½ and 11½ inches from ends of cask. Casks are lined with oiled paper; heads are set into recess at ends of staves in the usual manner, and also held in place by a band of ¾-inch split willow nailed to staves on each side of heads. Ordinarily when in warehouses in this country casks are set on end and not tiered.

Ammonium nitrate in transit would come under the following regulation of the Bureau of Explosives: "Nitrates in bags are grouped as oxidizing material and the maximum quantity in one outside package which may be shipped without a label is 100 pounds in one shipment. When it exceeds this quantity, the yellow label (inflammable solid) is required. Nitrates in boxes, kegs or barrels are exempt from label and certificate when properly so described."

The requirements for oxidizing materials are as follows:

"All oxidizing materials (except those for which specially constructed containers are prescribed, see Specifications Nos. 18 and 20) should be shipped in metal packages complying with Specification No. 20. When such metal packages are not available, strong and tight wooden boxes complying with Specification No. 9, or drums, kegs or barrels complying with Specifications Nos. 11, 21 or 22 must be used. Nitrates may also be shipped in bags or in bulk in tight cars."

Numerous tests are then described after which the report continues:

RATE OF PROPAGATION

It will be observed from the above tests that while blasting gelatine having a velocity of wave propagation of 6,000 meters per second or more was sufficient to detonate the ammonium nitrate, fulminate of mercury having a velocity of about 4,000 meters per second failed to have any effect. The natural inference, therefore, would be that the critical point in the detonation of ammonium nitrate would lie somewhere between the velocity of 4,000 and 6,000 meters per second.

For comparative purposes it may be noted that "Cordeau," that is, T. N. T. or trinitrotoluol, has a wave propagation velocity of 5,500 meters per second; blasting gelatine 6,000-8,000 meters per second, fulminate of mercury 4,000 meters per second, dynamite 1,500 to 6,000 meters per second, nitroglycerin 5,000 meters per second, and gunpowder an average of about 440 meters per second.

GASES EVOLVED

It will be observed that ammonium nitrate in the presence of high temperature, without organic matter being introduced in an incandescent condition, will throw off N_2O gas or nitrous oxide, which is commonly known as laughing gas, and, while it will render persons unconscious, is not a poison gas. This gas is given off at between 450 and 500 degrees F. When heated in contact with incandescent organic matter, NO_2 or nitric oxide is thrown off, which gas is injurious when breathed in high concentration or when breathed in low concentration for an extended period. Its effect is to cause the lungs to fill with water and suffocation results, as in drowning.

In the N_2O oxygen is very lightly combined with nitrogen and is released under slight provocation, thus tending to intensify the fire. It should be observed, on the other hand, that the nitrogen gas thus released is an inert gas and has a tendency to exert a cooling effect.

PHYSICAL PROPERTIES

As the properties and reaction of sodium nitrate ($NaNO_3$)

are fairly well known and understood and as this salt belongs to the same general group as ammonium nitrate, in dealing with the physical and chemical properties of the latter the two are compared.

Both sodium nitrate and ammonium nitrate are hygroscopic and deliquescent, but ammonium nitrate is more so. Sodium nitrate begins to melt to a saturated solution as soon as the vapor tension of water in the air exceeds 13 mm., while ammonium nitrate begins to deliquesce at 10.8 mm.

Both salts are soluble in water, but ammonium nitrate is the more soluble. At 20 degrees C. (68 degrees F.) 100 g. water dissolves 88 g. $NaNO_3$ or 186 g. NH_4NO_3.

Both, upon dissolving in water, lower the temperature, but here again the action of ammonium nitrate is more pronounced than that of sodium nitrate.

ACTION UPON HEATING

When sodium nitrate is heated out of contact with organic matter it first melts at about 315 degrees C. (about 600 degrees F.) and then gives off oxygen in accordance with the equation:

$$2\ NaNO_3 + \text{heat} = 2\ NaNO_2 + O_2. \qquad (1)$$

This means that $2 \times 85 = 170$ lbs. $NaNO_3$ yield $2 \times 69 = 138$ lbs. sodium nitrate and $2 \times 16 = 32$ lbs. oxygen.

When sodium nitrate is heated in contact with a combustible, say carbon, the following reaction occurs:

$$4\ NaNO_3 + 5\ C = 2\ Na_2CO_3 + 3\ CO_2 + 2\ N_2. \qquad (2)$$

This means that $4 \times 85 = 340$ lbs. $NaNO_3$ yield $2 \times 106 = 212$ lbs. sodium carbonate, $3 \times 44 = 132$ lbs. carbon dioxide and $2 \times 28 = 56$ lbs. free nitrogen. It also means that 340 lbs. $NaNO_3$ will burn completely to CO_2 $5 \div 12 = 60$ lbs. carbon. That is, 100 lbs. sodium nitrate contains sufficient oxygen to burn 17.65 lbs. carbon.

It should be pointed out that the sodium carbonate resulting will contaminate any unconsumed sodium nitrate and make its recovery more difficult. Both the sodium nitrate and the sodium carbonate are freely soluble in water.

When ammonium nitrate is heated with a combustible, say carbon, again the following reaction occurs:

$$2\ NH_4NO_3 + C = 2\ N_2 + CO_2 + 4\ H_2O. \qquad (3)$$

This means that $2 \times 80 = 160$ lbs. ammonium nitrate will burn completely 12 lbs. carbon, yielding $2 \times 28 = 56$ lbs. nitrogen, 44 lbs. CO_2 and $4 \times 18 = 72$ lbs. steam (H_2O in vapor form). That is, 100 lbs. ammonium nitrate contains enough available oxygen (the remainder being necessary to combine *with the* H of the NH_4NO_3 to burn 7.5 lbs. carbon

to CO_2. Weight for weight, therefore, sodium nitrate will burn $17.65 \div 7.5 = 2.35$ times the carbon that ammonium nitrate will.

It might be added that neither sodium nitrate nor ammonium nitrate are combustible, nor does either yield any combustible products, either as the result of direct heating or heating with organic matter, except, of course, where an excess of incandescent organic matter is brought in contact with these salts, when carbon monoxide can be formed just as it can be with any fire where there is an insufficient supply of air.

HEAT DEVELOPED BY DEFLAGRATION

As we have seen (equation 2), when sodium nitrate is heated with organic matter, the reaction is:

$$\underset{4 \times 110.7}{4\ NaNO_3} + 5\ C = \underset{2 \times 270.8}{2\ Na_2CO_3} + \underset{3 \times 97.65}{3\ CO_2} + 2\ N_2$$

Underneath the constituents of this equation have been written the heats of formation from the elements of the respective constituents in large calories per gram molecule. Adding up, there are 442.8 Cal. on the left and 834.55 Cal. on the right, an excess on the right of 391.75 Cal. The equation is hence exothermic from left to right, i. e., heat is evolved. Per 100 lbs. $NaNO_3$ the heat is 115.2 Cal. = 457 B. t. u.

When ammonium nitrate is substituted for sodium nitrate the equation becomes (4):

$$\underset{2 \times 88.6}{2\ NH_4NO_3} + C = 2\ N_2 + \underset{97.65}{CO_2} + \underset{4 \times 56}{4\ H_2O.}$$

Adding up, there are 177.2 Cal. on the left and 321.65 Cal. on the right, an excess on the right of 144.45 Cal. per 100 lbs. NH_4NO_3 the heat liberated is hence 90.2 Cal. = 358 B. t. u., or approximately 100 B. t. u., or 22 per cent. less than with sodium nitrate.

CONCLUSIONS

As a result of the tests and other data previously available, the following conclusions would appear to be justified:

1. Ammonium nitrate is normally inert and can be exploded only through detonation and then only by using as a detonator some high explosive through which the wave is propagated with extremely high velocity, probably not less than 4,500 to 5,000 meters per second, and that for storage in the ordinary warehouse the explosion hazard may be disregarded.

2. That ammonium nitrate, which is inorganic, is not, in itself, combustible, it has no inherent potential fire hazard and, *consequently, its storage* does not involve a DIRECT fire *hazard.*

3. That, considering the construction and material of the casks in which it is packed, a fire starting from the outside would take at least fifteen minutes to eat its way through the staves or heads to the salt, and sprinklers would, or should, have ample time to operate.

4. That the salt being highly deliquescent, should water reach it a heavy water damage may be expected, but with casks water-tight, of heavy material, well constructed and not tiered, and with good protection and especially with sprinklers, the fire should ordinarily be extinguished without serious water damage.

5. That when heated to 450 degrees or higher, not in the presence ot burning wood or other organic material, ammonium nitrate will give off nitrous oxide fumes, or laughing gas, which, while not deadly, if breathed for any length of time by fire fighters will render them unconscious, and in the presence of burning organic matter will give off nitric oxide fumes, which are injurious, and would prevent unprotected firemen from approaching the blaze too closely, and thus interfere with fighting the fire. Nitric oxide, however, is completely absorbed by the Burrell All-Service Mask, made by the Mines Safety Appliance Co.

6. That ammonium nitrate offers very much the same fire hazard as sodium nitrate, that is an indirect hazard through the liberation of oxygen at moderately high temperatures, which gas serves to intensify combustion and tends to increase the extent and spread of the fire.

RECOMMENDATIONS

It is recommended that, for storage, this material be treated the same as sodium nitrate, except that it be contained in casks instead of bags and that the casks be not tiered, but left open to ready protection from sprinklers or fire streams. Also that firemen use gas masks in fighting a fire of any magnitude in this material.

COTTON SEED OIL MILLS

Process Described; Experience Covering Term of Years; Requirements for Purpose of Reducing Hazards

By Owen A. Marrin, Supervisor, North British & Mercantile Insurance Company, New York

This class of business in the United States has become unprofitable in recent years, due principally to the declining rate and unless the mill owners are prepared to recognize this condition and effect certain reforms in their mills, then, of necessity, the rate must be materially advanced.

An underwriter of world-wide experience states that cotton seed oil mills outside the United States have proved profitable, due, in his opinion, to the class of labor employed, and better housekeeping methods, so essential to risks of this class.

The Southern negro, who is notoriously lazy, careless and indifferent, is blamed largely for the conditions in Southern mills, but proper supervision on the part of the mill management in enforcement of a high standard of service, can to a large degree reduce, if not eliminate, losses due to this class of worker.

The fact that in a majority of mills the operating season is short, and consequently the workers cannot look forward to permanent employment, which would be such a strong factor in requiring a satisfactory standard of work, is a handicap hard to overcome; but, the task is not an impossible one, and by proper selection and supervision, the available unskilled workers can be developed, and the efforts on the part of the mill owners will certainly be justified by the results accomplished, not only from an economic standpoint, but also in reducing the fire losses.

LOSSES CAUSED BY FRICTION

An analysis of the National Board of Fire Underwriters' figures of the years 1916, 1917, 1918 and 1919 shows that a large percentage of the losses are from preventable causes, which if they cannot be eliminated can be reduced materially. In this period there have been 128 claims for losses due to *friction,* involving insurance of $7,049,024 and values of $8,507,793; losses paid $2,006,261 with value of property destroyed $2,504,299. When we realize that these losses do not include sprinklered cotton seed oil mills, or losses paid by insurance companies which do not report to the National Board of Fire Underwriters, it is *quite evident* that this one subject alone is worthy of the serious *consideration of the mill* owners.

There are certain machines and equipment where friction fires are likely to occur, such as linting machines, seed cleaning machines, hull grinders, seed conveyors and attrition machines, which cannot be eliminated, but by constructing them of fireproof material and installing automatic sprinkler protection at these machines, or, if necessary, placing them in sections cut off from the main values, the number of fires would be reduced; also, and which is of more importance, only a small part of the total values would be involved.

With the great amount of lint and inflammable dust which collects on the walls, ceilings, bearings and shaftings, particularly that part of the millwright work which is oiled, and the heating of any part due to friction or the creation of sparks, the condition is dangerous, as the lint and dust are highly inflammable and fire spreads rapidly throughout the mill.

REQUIREMENTS FOR REDUCING HAZARDS

Requirements by the Association for the purpose of reducing the hazards are as follows:

"Lint from linters to be taken up and baled, and, when pressed, immediately removed from mill building or warehouses other than linter storage warehouses, or if stored in the open to be at least 100 feet from any building other than 'Linter Storage Warehouses.'

"Sweeper to be continually employed while mill in running, keeping every part of mill clean from dust, lint and cobwebs.

"Walls and ceilings may be quickly cleaned by a steam or air-blast from small hose. If steam be used, care should be taken to prevent same coming in contact with automatic sprinkler heads."

The following charges appear in the Rating Schedule:

	CLASS Frame	Brick
Lint—In excess of 15 pounds per linter allowed to accumulate on floor of linter room..................	.25	.15
Dust—Not blown or carried outside at least once in each watch to an approved dust house............	.50	.50
Sweeper—None, as required	.25	.25
Untidiness, Rubbish, Etc.—In mill, especially basement and outside of mill exposing	.10—.50	.10—.50
Note—This charge, when made, is applicable to existing policies.		
Machinery—Crowded or badly arranged............	.15—.25	.15—.25
Ginning—In mill (this charge includes the ginning, opening or cleaning of seed cotton or bolls, or boll-cleaning process, sometimes called "Grabot-Ginning," as well as regular ginning)................	2 00	2 00
Storage—Of cotton or linters in bales in mill or in frame building exposing within 60 feet of frame mill	1 00	1 00
(If mill is brick apply charges for exposures as per seed and other warehouses.)		
Lint Press Room—*In main building or in frame or I-C building within 15 feet, not properly cut off*.......	.25	.25

In frame or I-C building adjoining or within 15 feet, when properly cut off			.15	.15
In frame or Iron-clad building, over 15 feet and within 60 feet, not cut off			.05—.10	.02—.10
In brick building adjoining or communicating, but not cut off according to requirements			.10	.10
Note—If thoroughly protected by automatic sprinklers, **no charge.**				
Hull Grinding—In mill building			.30	.25
Protected by standard automatic sprinklers			.10	.10
If not provided with approved magnets and/or gravity drop pockets			.10	.10
Note—If mill has machine that hulls and produces a meal or fine "feedstuff," same is to be construed as "hull grinding."				
Attrition Mill or Cake Breakers—Not safely arranged.			.15	.10
Delinters—In room cut off by fire-wall, **no charge.**				
Approved machine and not cut off as above			.30	.25
Approved machine cut off by frame partition (not sprinklered)			.20	.15
Approved machine cut off by partition and dust blown outside, **no charge.**				
Care and Cleanliness—Bearings not regularly cared for, lint accumulation excessive, frame building not properly whitewashed at least once in every three years	.10—.50	.10—.50	.10—.50	.10—.50

Note—The charge for care and cleanliness is made according to judgment of inspector and varies from 10 cents to 50 cents, regardless of construction.

The thought being to penalize hazards so that it will be to the assured's financial benefit to bring their plants up to standard.

Co-operation on the part of the mill owners along these lines will not only be beneficial to them in an economic way by saving unnecessary waste; creating better hygienic conditions for the workers, thus increasing their efficiency, but will bring about a reduction in the fire waste and insurance losses, thereby justifying the present low average rate now existing.

It is usual to whitewash the walls of the mill and warehouse, which tends to reduce the accumulation of lint; also acts on fire as a retardant.

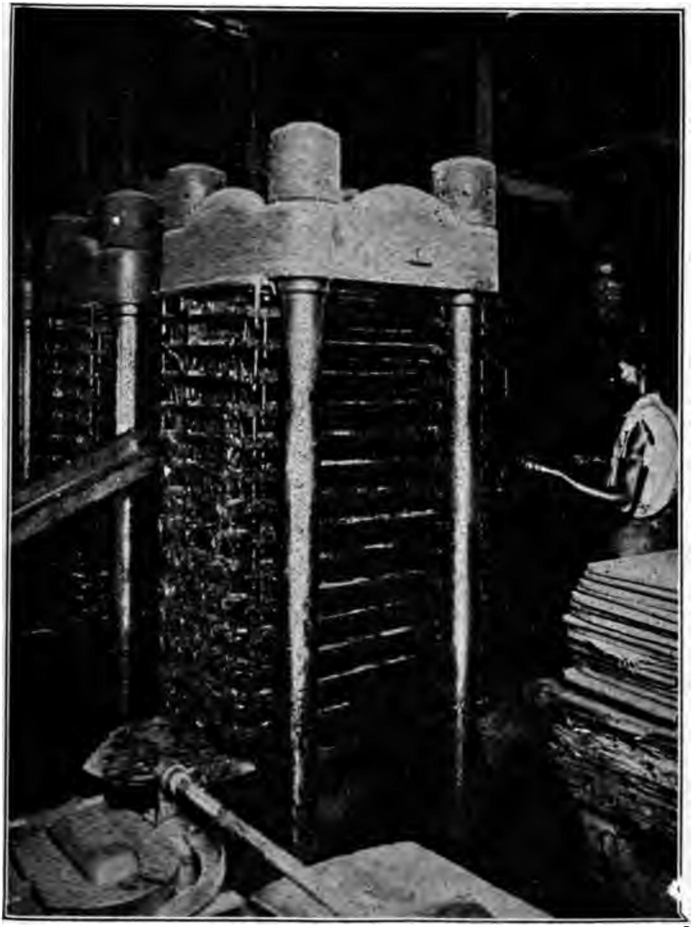
The friction hazard of seed conveyors in seed houses is a serious one, due to the introduction of foreign materials in the seed, such as stones, pieces of metal, which are likely to strike fire when in the seed tunnels, and, therefore, the seed tunnels should be of non-combustible material and sprinklered.

In up-to-date plants the seed tunnel has been eliminated and seed elevated and distributed by all metal elevator and conveyor.

SEED HOUSE AND SEED CLEANING

The seed when received at seed house is usually unloaded into conveyors and carried to the top of the building and from the conveyors is dumped into piles. As needed it is shoveled through

trapdoors in the floor, into the trough of a metal screw conveyor six inches in diameter; the boxing surrounding the conveyor is



Underwood & Underwood

HIGH-*POWER* COTTON-SEED OIL PRESS

usually of wood, but to be standard should be of metal and tunnel should be sprinklered as fires often start here, due to friction, and from their location and arrangement permit the rapid spread of fire.

The conveyor carries the seed to the seed cleaning machinery, which is usually located in the seed house in a room partitioned off from the balance of the building.

The seeds are mixed with varying amounts of foreign matter which it is necessary to remove. This consists of sand, dirt, bolls and locks of cotton, sticks and pieces of branches, pebbles, pieces of iron, etc. This separation is effected by means of inclined reels, or revolving screen of heavy wire netting, or perforated sheet metal.

The seeds are elevated by bucket-elevator and fed into the higher end of the reel; as they are moved toward the lower end there is a selective separation of foreign matter and seed according to respective size by means of different size openings in the screen. Pieces of metal may be removed by means of magnets located in any convenient place in the path of the seed.

The danger of fire from friction is very great, and if possible these machines should be protected by automatic sprinklers, chemical extinguishers, fire hose and casks of water and fire pails provided.

In connection with such machines the Association's requirements are:

"Seed should be cleaned by an approved system, such as sand and boll screen and blower; if blower not used in connection with sand and boll screen, magnets and gravity drop pockets should be used. Grabots and dust to be blown to outside of building and disposed of in satisfactory manner. Magnets to be cleaned every hour.

"Sand screens, if provided with magnets, to be thoroughly cleaned once in each hour, or oftener if seed be damp."

The Rating Schedule makes charges as follows:

	Bldg.	Stock	Bldg.	Stock
Seed Cleaning Machinery—				
(a) In building	.50	.50	.50	.50
(b) In separate room, partitioned off from warehouse or mill by tongue and grooved 1-inch boards (no concealed space), thoroughly whitewashed and protected by approved automatic sprinklers on ceiling of room, in machine and under machine, platforms or stairways......	.10	.10	.10	.10
(c) If seed cleaning machinery is of all metal and blower type system and sand screens (if any) and first cleaning are in separate room or building				

cut off by standard fire wall, openings (if any) protected by automatic fire-doors on each side of wall, no charge.

Some machines are provided with drop pockets which collect substances heavier than the seed; also, there is being introduced the pneumatic system for lifting the seed, similar in principle to that in use in the conveyors in the opening rooms to the main buildings of cotton mills, which method is proving very successful in removing all foreign material heavier than seed. Although there is no allowance at the present time for such a device, there is no reason to suppose that the Association will not allow a material credit in the rate for this safeguard. As an aid to reducing the hazards of seed storage some mills clean the seed before placing it in the seedhouse.

LINTER ROOM

By conveyor the seed goes to the linter room, which is located in the mill building and which should be cut off from the balance of the plant; also automatic sprinkler protection afforded, or fire hose, chemical extinguishers, barrels of water and fire buckets provided.

The purpose of the linters is to remove the short fibers of cotton which adhere so closely to the seed. These machines are similar in principle to the ordinary cotton gin where the seed comes into contact with the gin saws, each projecting through a slot in a grid which forms the bottom of the box. The saws are dull, fine toothed and about 10 inches in diameter. The fibers are caught by the teeth of the saw and are carried through the slots in the grid where they are brushed off by a rapidly revolving brush wheel.

This lint is then carried to the rear of the machine and made into a roll weighing about twelve pounds, which is then carried by hand to the lint press room and formed into bales resembling cotton bales.

The lint press room should be cut off from main building or be located in a detached building.

As an aid to the sweepers in removing the accumulation of lint and dust which collects around these machines, it is customary to raise them above the floor, all of which is for the maintenance of proper cleanliness which is so essential in this section of the plant.

These machines should be provided with electric magnets, over which the seed passes before entering the linters; also should be equipped with lint rolls and individual condensers.

The lint and dust hazard can be materially reduced if the machines are provided with cyclone blowers and metal conveyor system similar in principle to those in use in woodworking

plants for collecting and conveying sawdust to vaults or furnaces.

Static or frictional electricity is created to a marked degree in these machines and owing to the inflammability of the lint and the danger of fire from electric sparks which pass between the metallic parts of the machinery, this hazard should be eliminated by thoroughly grounding the machinery by the use of proper gauge wire attached to metal rod or pipe buried in the earth.

Even with all these safeguards the hazards of this room are very pronounced owing to the great amount of flying dust and lint, and the danger from hot bearings or sparks cannot be over-estimated.

The following charges appear in Rating Schedule.

From these machines the hulls are conveyed to the hull house and the meats go to the press room, where they are cooked by steam in jacketed kettles, which should be covered with asbestos as the temperature ranges from 200 to 240 degrees. There are no unusual hazards connected with the process.

PRESS ROOM

The meat after being cooked goes to the press room and is transferred directly to the cake-former, where it is subject to pressure just less than is necessary to express oil and formed into cakes approximating the dimensions they are destined to assume. They are wrapped in camel's hair cloth and inserted at once into the empty compartments or boxes of the hydraulic press, and sufficient pressure is applied (from 3,500 to 4,000 pounds per square inch) to force the oil out of the meal and running down the side of the presses, is collected and run into settling tanks.

The pressed cake is then removed from the machine; the press cloths stripped off, and as these oil-soaked cloths are considered hazardous, due to the danger of spontaneous combustion, they are daily removed from the mill and are washed and dried in the laundry.

The cake, which is a hard dried slab of meal three-quarters of an inch thick and 14x30 inches in size, is removed to the meal house or it is passed through the cake breaker or attrition mill, where it is coarsely ground and then passed through rollers and reduced to commercial cotton seed meal and is then ready for shipments usually going abroad to be used for cattle food, although a large percentage goes to fertilizer factories, as it is the most important of the vegetable ammoniates and forms an important part of the complete commercial fertilizer. There is no inherent hazard in the cotton seed meal.

SPONTANEOUS COMBUSTION

The danger of spontaneous combustion has evidently been

largely exaggerated as the figures of the National Board of Fire Underwriters for the four years, 1916-1919, shows as follows from this cause:

No. of Claims	Ins. at risk	Loss paid	Sound value	Whole loss
18	$1,032,630	$116,287	$1,197,632	$124,249

This hazard can be largely reduced by proper management, as it is well known that improper storage of seed or hulls, unnecessary accumulation of oil-soaked press cloths, or the accumulation of rubbish in corners or out-of-way places has resulted in fires from this cause.

Cotton seed when on storage in large piles for any length of time will heat, and as this reduces its value due to fermentation, the manufacturers by changing the piles around, or by introducing seed ventilating air ducts, endeavor to eliminate this hazard.

OPERATION OF HULLER

After the seed has been freed of the lint it goes to a machine called the "huller," where the hulls are separated from the meats. Before entering these machines the seed passes over electro-magnets to remove any pieces of metal.

The huller is constructed with one set of fixed knives and another set revolving within the fixed set. The two are so arranged that the edges of the knives are about 3/16 of an inch apart and in this manner the hulls are cut without damaging the meats.

The mass discharged from the huller is a mixture of meats, or kernels, hulls and meats with more or less of the hull adhering. The mixture of meats and hulls is subject to selective separation in the same manner as uncleaned seed. The revolving screen discharges the greater portion of the hulls at one end and allows the meats to escape through the perforations.

Subsequent separation of much of the remaining hulls is effected by means of a shaker.

The fire hazard of these machines is from friction due to clogging of the stock in the machines or from foreign substances creating a spark hazard.

If storage room permits the seed should be kept in separate piles and the seed piles kept as low as practicable.

If seed ventilating air ducts are provided they should be of non-cumbustible construction, with all outlets properly trapped and air taken from outside of building, which is liberated through perforation near base of the pile of seed.

Oil press cloths should not be allowed to accumulate, but should be washed and dried at proper intervals, as the general opinion is that oil-soaked press cloths will ignite spontaneously if allowed to pile up.

In hull houses many fires have occurred, due apparently to spontaneous combustion, as there is more or less oil remaining on the hulls and being allowed to accumulate in large piles for months, the whole mass is likely to heat and eventually take fire. Damaged and water-soaked hulls are hardly worth the cost of salvaging after a fire and total losses are usually paid.

Cotton seed oil is oxidizable and while undergoing oxidation it heats more or less and in combination with rags or rubbish under suitable conditions spontaneous combustion will ensue.

Sound ripe seed free from moisture is practically without spontaneous combustion hazard but if there is any considerable amount of unripe, damaged or damp seed then the danger from spontaneous combustion is a serious matter, and without proper handling by mill men fire will undoubtedly ensue.

. Damp seed or hulls will ignite spontaneously and the thought is to keep water from reaching the stock.

The roof of the building should be water tight and the floor raised a sufficient height to prevent dampness; also experience has proved that many fires have occurred in seed and hull houses from water leaking from the sprinkler system, and it is interesting to note the following report of loss:

"In a recent report with reference to a fire in an important cotton seed oil mill, which occurred early in September last, one of the Southern Adjusting Bureau reports on a more recent loss still unsettled, which seems to have been caused by the collapse of a portion of the sprinkler system drenching the cotton seed hulls in the seed house and thereby causing spontaneous combustion. Incidentally, it would appear also that this fire is likely to be a continuous performance.

"'On October 6 fire broke out in the west section in the center of a pile of hulls, which bears out the theory that wet hulls will cause spontaneous combustion. The loss has not been

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Lint—In excess of 15 pounds per linter allowed to accumulate on floor
Linters—On raised platforms (not floors) combustible material........
If space under platforms thoroughly protected by automatic sprin-
Linters not provided with approved magnets, each (not exceeding
Linters not provided with condenser and linter roller, each (not
Lint Press Room—In main building or in frame or I-C building with
In frame or I-C building adjoining or within 15 feet, when pro-
In frame or iron-clad building over 15 feet and within 60 feet, not
In brick building adjoining or communicating, but not cut off acc-
Note—If thoroughly protected by automatic sprinklers. **no charge.**

STORAGE OF BALED LINTERS

Linter Room—When not cut off by standard fire-walls from adjoining
ing, opening (if any) to be protected by approved automatic fire-
openings ....

adjusted as the hulls are still burning, the fire rekindling itself every day.'"

MATCHES AND SMOKING

The figures of the National Board of Fire Underwriters for four years show losses from these causes as follows:

No. of Claims	Ins. at risk	Loss paid	Sound value	Whole loss
18	$744,092	$162,857	$893,060	$172,651

With the increase in cigarette smoking this is a serious hazard and the "no smoking" rule should be strictly enforced and should be made to apply to *all* the office as well as the mill workers, for if the rule is enforced only with the mill hands it is likely to cause resentment, and there is no doubt if the "no smoking" rule applies to all, that its importance will be more fully realized and tend greatly to its absolute enforcement.

Smoking is often done secretly and to prevent discovery and discharge the burning tobacco is thrown hastily aside and what is often reported as a fire of unknown origin can be attributed to this preventable cause.

In a mill where the lax management does not strictly enforce the smoking prohibition it is to be expected that poor care and cleanliness will be the rule rather than the exception, and with the accumulation of lint and inflammable dust this hazard is a serious one.

It is perhaps needless to say that parlor or snap matches should not be allowed on mill premises and if matches must be used, only safety matches should be permitted.

Tests made at various times have shown that the parlor or snap match is a serious danger in risks where there is an accumulation of lint. There is the chance of loose matches being mixed up in the stock and carried through the machinery and creating fires.

	Class of Building Being Rated				
	C-D, I-C	B	AA	I-C-M	AAA
of linter room..........	.25	.25	.25	.15	.125
....	.10	.10	.10	.06	.05
klers, **no charge.**					
over 5 to be charged for)	.05	.05	.05	.03	.025
over 5 to be charged for).	.10	.10	.10	.06	.05
In 15 feet, not properly cut off	.25	.25	.20	.15	.10
perly cut off............	.15	.15	.10	.06	.05
cut off	.05-.10	.02-.10	.01-.03	...	...
ording to requirements..	.10	.10	.10	.06	.05

	Class of Building Being Rated				
	C-D, I-C	B	AA	I-C-M	AAA
rooms or exposing build- doors on each side of	.15	.15	.12	.09	.075

ELECTRICITY

This hazard is a serious one as indicated by the figures:

No. of Claims	Ins. at risk	Loss paid	Sound value	Whole loss
14	$1,169,075	$251,844	$1,316,871	$465,499

In addition we can readily assume that many fires start from defective equipment, but are reported as "cause unknown."

With the large amount of lint which accumulates throughout the mill and warehouse and considering the great inflammability of the lint and dust, it can be readily appreciated how important it is that the electrical equipment be maintained according to standard. Improper insulation or an electric spark under such circumstances is exceptionally hazardous, particularly if in an inaccessible location, and this feature should have the most careful consideration.

The following figures are interesting:

	No. of claims	Ins. at risk	Loss paid	Sound value	Whole loss
Sparks from combustion	28	$1,064,753	$185,714	$1,621,415	$266,248
Miscellaneous	22	1,034,064	249,797	1,107,857	397,098
Stoves and furnaces	5	65,718	26,701	137,400	52,013
Incendiarism	1	15,000	13,500	14,706	13,500
Sparks on roof	11	269,291	9,299	288,426	11,399
Exposure	20	441,591	42,157	573,915	56,776
Lightning	13	209,900	77,642	223,370	83,328
Unknown	103	7,468,871	1,207,149	9,403,794	1,672,786

As a rule, the electrical equipment is subject to rough usage and often carelessly installed during the rush season. If installed in approved metal conduit this hazard will be materially reduced.

In seed and hull houses vapor-proof globes and metal guards of approved marine type should be used.

It is understood, of course, that the equipment will be in compliance with the National Electric Code.

In the sections where the lint hazard is pronounced, such as linter and linter press rooms, seed tunnels, seed houses and seed cleaning machinery, pendant lights and side wall receptacle should be avoided.

LOSSES OF UNKNOWN ORIGIN

It is human nature that when we have to consider something concerning which the true facts cannot be determined, to always choose the worst construction, which in this case would be "moral hazard," or the deliberate and criminal destruction of property by fire, on the part of the interested parties.

Another viewpoint is that the fires spread so rapidly that point of origin could not be determined, or that the fires started after plants had to be shut down for the day and with inadequate *watchman's service* was not discovered in time.

Hasty adjustments without making proper investigation as to *the origin of the* fires or the circumstances surrounding the

same which would permit reasonable judgment are largely to blame for the number of fires reported to be of "unknown origin."

If we are honestly determined to improve the conditions which result in fires it is imperative that this feature be given serious consideration by those who have the power to enforce proper investigation as to origin or causes which have resulted in an undue number of preventable fires.

A careful review of the figures quoted shows that the whole loss exceeded the losses paid by a good margin, which would seem to eliminate the question of moral hazard to a large extent. There was only one loss reported of incendiary origin and it is interesting to note that the insurance exceeded the sound value.

The figures published by the State of Texas only add emphasis to the unprofitableness of this class, and as Texas is the largest cotton producing State, and consequently has the greatest number of cotton seed oil mills, these figures are deserving of serious consideration.

BRINGING INTERESTS TOGETHER

Increasing the rates will not reduce the fire waste and every effort should be made to bring the insurance companies and the cotton seed oil mill interests together for the purpose of securing the fullest co-operation in eliminating or reducing the fires from preventable causes to a minimum.

TEXAS—COTTON SEED OIL MILLS

Year	Liability assumed	Premiums	Adjusted loans
1913	$10,006,884	$164,010	$149,638
1914	11,371,921	162,074	223,958
1915	11,053,614	149,979	219,078
1916	14,305,746	182,343	71,907
1917	20,286,981	255,438	296,761
1918	20,535,272	405,969	199,727
1919	19,324,535	320,040	342,515
1920	15,419,600	220,109	320,701

Year	No. of fires	Average rate	Burning ratio	Loss ratio	Average ratio
1913	138	1.638	1.495	.912	1080.67
1914	247	1.425	1.969	1.382	906.69
1915	286	1.357	1.972	1.461	766.01
1916	205	1.275	.503	.394	350.76
1917	302	1.259	1.462	1.162	982.65
1918	248	1.997	.973	.492	805.35
1919	199	1.656	1.772	1.070	1721.18
1920	478	1.427	2.079	1.457	670.92

OTHER HAZARDS INTRODUCED

Because of the ravages of the boll weevil in certain sections of the South the planters have abandoned the raising of cotton to a large extent. This has forced some of the mills to seek other means of revenue and they have introduced the crushing and

handling of copra, soya beans, peanuts; also feed grinding and mixing, and many have added fertilizer mixing.

The records of peanut oil mills and feed grinding, if anything, are worse than the record on cotton seed oil mills, and although charges are made for these added hazards, it has only tended to make a bad situation worse and increased the underwriters' burden in attempting to place the class in the profitable column.

CANDY FACTORIES

Number of Plants Has Increased Enormously—Processes and Materials Furnish Wide Range of Possible Fire Hazards

By Walter L. Clark, Fire Protection Engineer, New York

Confectionery establishments numbered in 1919 3,148. In 1914, 2,391 are listed, with invested capital of $447,800,000 in the former instance and $107,845,000 in the latter, showing an increase of over 162 per cent. By order of importance New York is followed by Massachusetts, Illinois, Pennsylvania and Ohio. It is significant to notice that Ohio maintains a very fair and increasing worth in this industry. Most of the 48 chocolate establishments mentioned are sizable, considering that chocolate preparation requires heavier installation for roasting, grinding and needs to be adequately housed. On the other hand, candy manufacturing concerns, of which a total of 3,148 is spoken of, are more mixed in size, quality and quantity of apparatus required. This more numerous small factory is the more likely to be in tenant manufacturing buildings.

Often the construction of them is inferior to the modern industrial plant design. Tenants in such depreciated buildings seem to employ the poorer methods of housekeeping, and this double deterrent seems accountable for more fires than from the inherent hazards of the industry. Under these common causes the National Board of Fire Underwriters reports fires from boilers, including special equipment, as 19 2/10 per cent; rubbish and sweeping 15 1/10 per cent, of a high total of 34.

For instance, fires are imminent where cooking by gas heat is done, where cookers are not provided with proper flues for carrying heat and flame well apart from partitioning or frame window sills. This is manifest in quite a number of confectioners' small single floor or cellar premises in New York. Uncertainity of intention on part of the candy maker to reduce hazards, whether he be Greek, Italian or Jewish, adds to the hazard. Again, tucked away in a basement is a frame starch room, its floor, sides and ceiling maybe covered with older material left from arranging starch forms in former candy making. Certainly at times there has been starch dust in suspension. In close proximity are open gas lights or gas or coal candy stoves which could contribute the necessary ignition for an explosion, particularly if boiling over of the kettles occurs. And here, just where watchfulness should prevail, we find attention divided between *cooking and* the upstairs candy store counter sales—*one man to do both.* In short, arrangement, order and super-

vision are often lacking, perhaps not quite so much among the Germans and French and those practicing approved business methods.

In extent, this class of business is being increased greatly in cities. Here the police department recorded in 1915 small confectionery stores with manufacturing as 9,499, and in 1921, 10,700, an increase of 12 per cent. Also numbers are looked for this year, possibly owing to prohibition of saloon trade. For our business it is beneficial to know that in 1913 the health department enforced ordinances prohibiting ice cream, confectionery and baking being done in basements where head room was less than eight feet, and that since then all new buildings must have a cellar ten feet high. By this there was a great elimination of the close, musty and squalid quarters so injurious to the health of the employes. Keeping constant rigid observance of pure foodstuffs in manufacturing ice cream, but not confectionery, municipal inspectors are also calling attention to untidy, unkempt and poor surroundings as being unsanitary, particularly during the approaching summer season. This thereby lessens the possibility of fire and offsets the rather unfavorable influences so that the underwriter may find the class profitable in a moderate degree.

Under this cause for fire we might cite improper condition relating to stock arrangement and building construction, as in the case of a larger and supposedly better tenant manufacturer. The Diamond Candy Company (five-story brick building) had on its second floor a full supply of paper candy boxes placed on the stair landing. This took fire. At the start the fire cut off the wood inclosed stairs, and owing to non-automatic traps at the landings the fire spread rapidly. Combustion of this kind would have been deferred if this staircase and other openings had been inclosed in fireproof construction, or at least had there been a partition of metal sheathing over matched boarding. Better chances for retardation would have been gained from the work of a standard automatic sprinkler system, and likely would have saved this company's investment. Fires in seventy-two candy risks, particularly noticed, showed that 73 per cent were extinguished by sprinklers. As in this instance where preventatives were lacking, so it is in older buildings of like joist construction occupied by the manufacturers of cheaper grade candies so familiar to us. Contrary results from fire would be anticipated in mill and fireproof construction, as either suffices for the better class industry and to produce under care and arrangement profitable insurance returns.

CANDY MAKING

In general candy making constitutes the submitting of the raw stock, of which sugar, corn syrup, chocolate and flavoring and coloring matters are the principals, to various degrees of heat

and to subsequent cooling, shaping and packing the cooked result. Sugar may be considered the basic of all candies.

EFFECT OF SPRINKLERS BY CLASS OF OCCUPANCY

	Candy factories	
	No.	Per cent
Extinguished fire	101	71.2
Held fire in check	37	26.0
Total satisfactory	138	97.2
Unsatisfactory	4	2.8

Total fires, 142.

ARRANGEMENT OF FACTORIES

Generally processes are so arranged that the first are done on the upper floors and proceed downward. Hence cooking kettles, vacuum pans, sugar pulverizers, depositors, starch moulds, dry rooms, hard candy benches, nut roasters and machinery will be located in the upper floors of candy factories. Chocolate coating, wrapping and cutting and the accompanying machinery will be found on floors below; packing and finished goods below these. Storage of sugar, glucose, chocolate, etc., is often located in basements, where also refrigerating plants are.

The larger modern candy factories frequently have auxiliary departments for manufacturing paper and wood boxes, also printing plants for printing wrapping papers, advertisements, etc. When such is the case extra special hazards will be introduced into the factory, but these will not be considered here.

From this it may appear that elaborate processing brings about unduly severe hazards, but presently it will be shown that the majority of the processes are simple and are confined to apparatus of comparatively safe standards, except in regard to starching, pulverizing of sugar and ammonia cooling, all of which will be spoken of later. This will cause some reversal of favorable opinion, and this judgment will not be misplaced when we consider the latter as explosion risks.

The first process is generally the cooking of the sugar, corn syrup and principal ingredients, and this is done in copper or brass kettles heated by steam in the more modern factories, but also by coal, coke or gas. In the steam-heated kettles the temperature required is regulated by the pressure of the steam. These kettles are not of high value, about $350 to $500 apiece under the present high prices. Their principal dangers are due to boiling over of the syrup onto the fire, when it may flare and ignite adjacent inflammables. Protection from this heated syrup overflowing should be afforded when the furnaces rest on a brick or cement platform with raised edges. Batteries of furnaces should have ample safe flue deliveries to chimnies. Cooking *kettles, vacuum* kettles, candy furnaces and nut roasters *should be considered* as low-grade furnaces. Floors and ceilings

should be incombustible and kettles should have hoods over them and coal and coke furnaces provided with proper flues. Where steam is used to heat kettles there is little hazard other than that incident to steam pipes. Gas, coke and coal heated furnaces introduce a hazard of igniting the contents if the kettle should boil over. Vacuum kettles are also used, being enclosed kettles from which air and steam can be exhausted by power-driven air pumps during the process of cooking. Vacuum kettles are worth about $2,000 at present. The use of the vacuum kettle permits of a larger proportion of glucose, reduces the water constitutents and reduces the time required in cooking. Boiling in vacuum kettles is done under vacuums of twenty-six inches. The hazards are from the attaching of the piping thereto.

During the process of cooking various means are used to prevent crystallization on the sides of the kettle to prevent too rapid melting and to regulate changes of temperature. Ingredients are stirred or not, flavorings are added, etc., according to the result required. Kettles with mechanical stirrers are used.

COOLING PROCESSES

When the cooking process is complete the material is removed from the kettles and is treated in various ways, as follows for hard candy: The cooked batch is usually poured to a marble table with movable iron edges and allowed to cool. Sometimes steel tables containing a cold water circulation are used. This stiff dough or paste is placed in front of a heater on a "hard candy bench," where the heat gives a gloss to the surface and keeps the mass warm while it is being rolled out by hand into rods about one-half inch in diameter, which are cut into short lengths, allowed to cool, wrapped in paper and packed.

The hard candy bench is a long wooden table, at one end of which is an arrangement for providing considerable heat by direct radiation. Such batch warmer usually is a portable gas stove with asbestos radiators. The table is sometimes covered with canvas and the candy is placed on the canvas in front of the stove and worked. High-pressure steam pipes are sometimes used instead of gas for heat. Some manufacturers consider that sufficient heat from steam pipes cannot be obtained for some classes of hard candy.

When made of wood the parts near the heating appliance should be covered with sheet tin or zinc and the canvas-covered table should have tin below the canvas. Where possible steam pipes should be arranged clear of woodwork and should be used instead of gas jets and asbestos radiators.

MAKING CHOCOLATE

Chocolate work includes the making of "centers," afterwards *to be coated with* chocolate. "Fondants" and creams are cooked, *and in some cases* are worked to the proper consistency in mixers

or heaters. This mixture is then run by machine into shallow wooden trays. This machine, known as a "mogul," fills trays with starch, impresses plaster of paris patterns and fills these moulds with cream. The trays are then taken off to be set aside for hardening, and when ready are returned into the machine, which separates these "centers" from the starch and discharges them ready for coating, tre starch going again to fill the trays for further use.

A "mogul" when made of wood is of about $2,500 to $4,000 value; when made entirely of steel, $4,000 to $6,500. There is reason for having such handling of starch in a well-ventilated place, as it frequently is, though the dust hazard is more particularly pronounced in the dry rooms.

DRY ROOMS

Dry rooms should be built of fireproof material and properly vented, and without open lights, as dust is raised in stacking and unstacking the trays. Manufacturers of electric lights have shown beyond doubt that an explosion can be produced by the breaking of an electric lamp in a dusty atmosphere. In order to prevent the accumulation of dust so that a dust explosion could not become disastrous, also for the purpose of keeping rooms clean, all ledges or surfaces where dust may accumulate should be placed at an angle greater than the angle of repose for dust. Dust that accumulates becomes very dry, inflammable, and if in any way brought into suspension is subject to easier ignition.

Dry rooms are steam heated to about 110 degrees for marshmallows, gumdrops requiring 140 degrees, in which temperature these articles are left two or three days to reach the required state.

Dry rooms should be of fireproof construction, cut off from other rooms, being usually steam heated. The steam pipes should be so arranged that combustible trays, racks, dust and rubbish cannot come in contact with them. All corners and spaces in dry rooms should be kept clean and free from combustible material. Dry rooms are sometimes heated by air being blown in through steam-heated coils. When this arrangement is used thermostats have been installed in the dry rooms, connected with a switch controlling the motor which operates the fan. When heat rises beyond the desired temperature the fan is stopped automatically.

BOLTING MACHINE

These are for sifting and cleaning the starch used in casting "centers," etc. Although the starch is used again and again it is necessary *to sift* and clean it periodically, about two or three *times a year,* according as it is used. The machines are simple

mechanical sifters, largely made of wood and of small value. These should be within fireproof partitions.

Starch bolting is accompanied by an amount of starch dust which may cause an explosive mixture and should be done in fireproof enclosures without open lights. Dust should be removed frequently. Starch bolting rooms should be ventilated.

Coating of centers with chocolate is done in several ways. The chocolate is obtained from the chocolate manufacturers in cakes, which are broken up and melted in a hot water heated mixer. Centers are placed by hand on a traveling belt, which carries them up to the coating machine, then a wire traveling apron takes them through the machine where liquid chocolate is poured over them and forced up under them, and the excess of chocolate is blown off just as the coated centers leave the machine. They then are automatically transferred to a belt carrying waxed papers which takes them through a partition to the cold room, kept at about 65 degrees F., where the coated centres on the papers are taken from the belt and set on trays to harden. The waxed papers are returned and used again. The coating machine is essentially an apparatus for causing a stream of warm liquid chocolate to cover the centres and provide a current of air to remove the excess of chocolate, at the same time heating and mixing the chocolate. The chocolate is first melted and mixed in steam heated kettles and fed to the coating machine known as the "enrober," located in a warm room. This machine is heated by steam, an auxiliary gas heater being used at the start.

Chocolate coating machines are heated by steam or hot water, but often have gas jets attached that are used for the first heating. All gas jets in a room should be controlled by one valve so that all may be shut off when work is stopped.

This machine costs about $2,500, present prices from $4,000 to $6,000 and with attachments about $1,500 more for making fancy candy.

Hand coating is used when a peculiar style or result is desired for coating certain pieces which cannot be covered in a machine. Chocolate is melted in large melters, as for the machine work and then pots are filled with the melted chocolate and kept at a temperature from 80 to 90 degrees by steam, gas or electric heat. These pots are usually set in the centre of large tables where women take the "centres" one at a time, dip them in the melted chocolate by hand and set them on waxed papers to dry. Sometimes nuts, etc., are placed on the tops of each while the chocolate is soft. Electric warmers are generally used because of the even temperate heat that can be easily handled by the operator. Here pilot lights should be supplied. Chocolate heaters

warmed by gas jets should be properly guarded from tables. There is danger from over-heating chocolate pots.

PAN WORK

Nuts, almonds, etc., are blanched, roasted or prepared in various ways and put into revolving pans; various prepared syrups and sugar are then poured on the nuts as they revolve and tumble together; each becomes coated in a uniform manner and more syrups are added according to the thickness of the coating required. Sometimes these coated nuts are polished by tumbling them in revolving pans.

PREPARATION OF NUTS

Various kinds of nuts, almonds, etc., are used as centres for chocolates, Jordan almonds and for mixing with nougats and various kinds of candies.

Peanuts are roasted and stripped of their husks and skins before being used. In roasting the peanuts are placed in revolving drums over gas, coal or coke fires at considerable heat. There are machines for roasting of various sizes, but it is common to roast about 160 to 300 pounds at a time, requiring about 25 minutes. Roasters usually have chimneys attached to remove the smoke and in all cases should be well raised from the floor and properly guarded from combustibles. When roasting is completed the nuts are run out on iron trays to cool, sometimes by exhausting cold air through them as is done with roasted cocoa beans. Nut roasters and gas, coal or coke heaters should preferably be in cut-off fireproof rooms.

Peanut skins are removed in a "blanching" machine, in which the roasted nuts are brushed against a corrugated board.

Finished candy, particularly chocolate work, must be kept at an even moderate temperature and some form of refrigeration is necessary to keep rooms at a sufficiently low temperature in summer. Brine, cooled by expanding ammonia or direct expanding ammonia, is circulated in pipes, usually placed near the ceiling, the ammonia compressing plant being in the power house. Sometimes air is cooled by drawing it through coils of direct ammonia pipes and discharging it into the rooms. Temperatures are 50 to 60 degrees F. In these or similar rooms is where packing of candy boxes is done. Paper, largely paraffine paper, cardboard boxes and cotton batting is used freely. The best of housekeeping should prevail here. There is also bulk storage of these paper boxes, fancy paper, ribbons, tinfoil, etc., and other materials, chiefly sugar in granulated form in barrels, corn syrup in barrels or cases, molasses in barrels, chocolate in cakes, packed in bags and cases. Flavoring extracts, coloring matter in cans, starch in barrels, paraffine paper, excelsior in cases and bales; all in basement. There is no important hazard

except that any large quantity of alcohol should be stored outside. Practically all such raw materials are inflammable and highly susceptible to water and smoke damage. This fairly concludes the listing of processes and machines in the factories, except that in the larger establishments it is usual to receive raw cocoa beans and entirely refine them for chocolate work. As in chocolate works, pulverization of sugar by them has become popular through extenuating circumstances during the recent war.

Candy makers often do their own sugar pulverizing. High speed revolving disintegrators are used. The pulverized sugar is blown to a cyclone separator, the fine dust passes on and is collected in canvas bags.

Sugar pulverizing and regrinding of sugar candies produce much dust of an explosive nature. It should be done in dust-proof enclosures ventilated and without open lights. Grinders and pulverizers should be fitted with magnets to remove particles of iron. Sugar dust should be frequently swept up and not allowed to collect.

The process of pulverizing should be done in a detached building used for no other purpose and located at a safe distance from other property. If the process is permitted in the main plant it should be segregated to a one-story addition or a roof structure, or in a separate room preferably on the top floor of the building. Walls, floor and ceiling of the room should be constructed dust tight and of incombustible material, capable of withstanding a standard one-hour fire test, except that an exterior wall or the roof should be constructed of light incombustible material, preferably of thin glass windows having a combined area equal to at least one square foot for each twenty cubic feet. A standard self closing, two ply, tin clad fire door, or its equivalent, should protect entrance to room. When the mill discharges to another floor, above or below, that portion of such other floor containing the powdered product should also be enclosed in a similar room. If necessary, in pulverizing cocoa or any other oily products, the apparatus may be enclosed in a room of ice house construction, cooled by a brine circulation refrigerating system. All rooms or enclosures in which the process is carried on shall be well ventilated.

Electric motors, unless of the totally enclosed type, or other spark preventive devices, shall be located outside of room, with the shaft or bolt holes reduced to a minimum and so arranged as not to expose the contents of the room, nor be placed in a line with dust travel therefrom.

LIGHTING

Only electric incandescent lighting shall be permitted in rooms *where any of those* processes are carried on. All wiring shall

be installed in rigid conduit and in accordance with the Code. All fuses or protective devices must be located outside of room, unless of the vapor proof type. All lights must be surrounded by vapor proof globes and approved wire guards.

The material should be passed over a magnetic separator before reaching pulverizer. Where practicable a one-fourth inch wire mesh screen shall be placed in hoppers or chutes feeding pulverizers. If the nature of the material handled will not permit the use of a suitable screen, a pneumatic or other separator should be installed and so arranged as to eliminate all foreign materials which are not subject to magnetic influence. If the mill is fed from the floor above, the curbing for chute should be raised at least seven inches. Cloth types of separator through which the powdered product passes before being barreled should be enclosed in metal casing.

RELIEF VENTS

Explosion relief vents shall be liberally provided on all pulverizing equipments, particularly at or near the mill in the discharge therefrom; at elevator heads, at storage bins for pulverized products, at cyclone dust collectors and at metal enclosures for cloth type dust collectors. Vent pipes should lead by the most direct path to the outside air. If bends are necessary in pulverized stock conveying ducts, a vent pipe should be installed at the bend and extend in a line with the direction of travel of the material prior to reaching the bend. When necessary, the outlets from explosion relief vents may be normally closed by a counter balanced, hinged relief valve provided with a soft felt gasket at least three-fourths inch thick.

In the case of pulverizing sugar on a large scale where a "sweet-water" tank is used, the tank shall also be equipped with vents (without pads) and the sugar dust met with a spray of water sufficient to prevent the escape of dust.

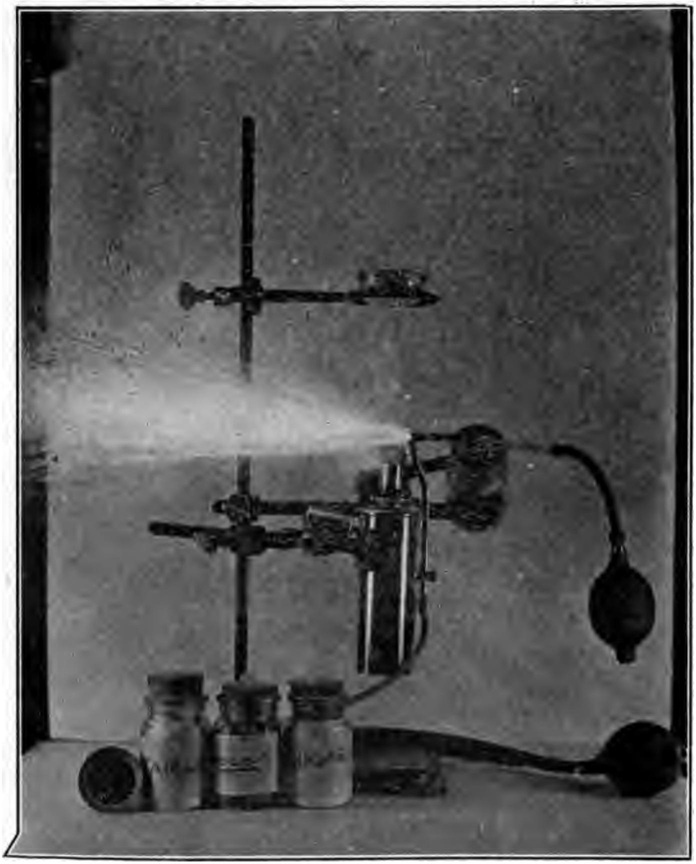
BLOWER INSTALLATION

Blowers shall be installed on proper foundation and secured in a substantial manner and shall not be used for any other purpose. Bearings of blowers shall not extend inside of blower casings or ducts. It is recommended that oilless self lubricating bearings be used made of bronze bushings with plugs such as graphite or metaline. All connections between discharge end of blower and main duct must be made so as to prevent leakage of fine dust. Blowers through which inflammable materials pass should have blades of composition, copper or brass. Ample clearance shall be provided for all blades.

Processes should preferably be located in sprinklered buildings. *Pulverizers* and all shafting should be electrically *grounded.*

As possibly illuminating this danger was the fire and explosion in the Arbuckle Sugar Refining of April 28, 1911. Processes were disposed from fourth to top floors of this nine-story semi-fireproof building, in the following usual order:

It seems that from a small fire breaking out in an adjoining



TESTING EXPLOSIBILITY—SEE PAGE 73

building, fire transmittal reached pulverizing operations on the fifth floor, blowing off the top of the pulverizer connected with a dust collector on the sixth floor. All of these floors suffered heavy damage, which shows that other than the construction isolating this apparatus, as previously recommended for the location of machinery and conveyers if extensive, there should be arrangement provided so that what few floor openings exist may be protected in a standard fireproof manner. For here it was that the bad feature of the wooden sugar bins passing through the sixth floor, in burning left large openings. But of as much significance was the release of burning sugar from these combustible bins, flowing over the floors and adding to the intensity of the fire. Here metal or incombustible material would have made this bin into a fireproof floor enclosure. This situation is not gravely alarming owing to the reports which appear to show only meager explosions, but a tendency towards severe hazard is always present which may well give underwriters considerable concern.

APPARATUS FOR TESTING EXPLOSIBILITY

This mechanism consists of an ordinary laboratory standard and its attachments; "Vulcan" alcohol torch; bottles of four-ounce capacity and rubber corks with two holes, one through which air is forced by bulb compression and the other through which the same air is expelled over the torch flame after being disintegrated by the tube passing up on the right of the torch. This tube is also connected with a bulb which supplies oxygen to the torch flame and intensifies it. Any kind of dust can be tested with this apparatus. If of explosive character the dust flame will be from 12 to 18 inches long. The ring over the torch is to hold a receptacle for boiling syrups which, when they overflow and come into contact with the flame, show inflammability of high degree, instead of acting as a damper to the flame, as is often supposed they would At the left of the bottles in the picture is a metal cup connected with a rubber tube. This is not part of the apparatus described; it is merely a simpler way to test explosibility of dust, which when placed in the cup can be blown into contact with a candle or other flame, by one's breath. The bell and tube tester has not the efficiency of the larger apparatus, but for a hastily prepared experiment it would answer the purpose. The advantage of the alcohol torch is that this apparatus can be taken anywhere and the experiments made regardless of whether the location is equipped with gas or any other means of producing a flame. Also, the alcohol flame is a hot flame and better adapted to the experiment. The entire cost of this apparatus is $5 and the parts can be purchased in any store carrying laboratory supplies.

ACETYLENE LIGHTING ON FARMS

Fire Hazards Produced—What Statistics Show—Loss Figures —Illuminants as Fire Causes—Danger from Acetylene —Other Hazards Involved

By J. I. Banash, of International Acetylene Association. Before Convention of Mutual Fire Companies at St. Louis.

We realize that the members of your organization and their representatives have intimate and detailed knowledge of farm properties which is not always available to other fire insurance companies, especially those which have not found it feasible to inspect such isolated risks. It may be taken without argument that just at the present time anything that will induce people to return to farms is of benefit to the entire country, and naturally anything which will induce them to stay on farms longer than they otherwise would will produce similar benefits. No one can doubt that good lighting is a benefit in itself and in a large measure can help to solve the problem of a happy existence in a small community.

Naturally we do not want to overcome one evil by another, and if good lighting introduces too much hazard either to life or property, it is evident that the problem is not solved. This is an attempt at a very frank discussion of the hazards involved in lighting by an isolated carbide plant, and to present for your consideration certain data which have been selected from as reliable sources as could be found, and to offer this data in such a way that possibly some actuarial deductions can be drawn.

HAZARDS INVOLVED

In the fairly distant past there was a hesitancy on the part of some insurance companies to insure homes with carbide lights, but fortunately this attitude has become or is rapidly becoming a thing of the past, for the reason that the actual loss ratios indicate that the acetylene industry has safeguarded its product to a reasonable and acceptable degree. With the help of Underwriters Laboratories, construction specifications have been developed and applied, which, when followed by the reputable manufacturers, throw definite safe-guards around the process. At the same time the National Fire Protection Association and the National Board of Fire Underwriters have developed and promulgated specifications covering the installation, maintenance and use of these plants. All the information is available without any more trouble than asking for it, and is constantly operating to promote properly made and properly installed apparatus.

As one reviews the history of acetylene lighting, and the flood of flimsy apparatus put out in the past by almost anyone who could solder sheet metal, the wonder is that there were so few accidents. During that period when so many machines were being marketed without due regard for safety, it was very difficult and expensive for those who were carrying on developments along scientific lines. Even now many years since standard forms of generators have been adopted and the gas has come into universal use, the echo of the past has not entirely died, and time and again fires and accidents are still reported as caused by acetylene if anyone mentions gas as having been used in the vicinity. Many and many a time have I personally investigated accidents so reported and often have found either that no acetylene was being used on the premises or that it had nothing to do with the fire, and in some cases the machine was still operative. Nevertheless the reports had already gone out through the press, and there was little if anything to do but make record of the facts for future reference. Unfortunately it is extremely difficult to get a newspaper to correct anything they have printed, and when they do make a correction rarely, if ever, is it placed in the same prominent position as the item which was originally printed.

WHAT STATISTICS SHOW

Now let us consider a few statistics covering the subject in detail, especially as regards the fire hazard. Some of you may perhaps be surprised to learn that there are some 285,000 homes lighted by acetylene in the United States. Present estimates indicate that about 80 per cent, or 228,000 generators, are of the type known as approved or permitted devices, that is, are or were included in the lists of standard mechanical appliances issued by the Underwriters Laboratories of Chicago to indicate compliance with standard construction specifications. The remaining 20 per cent., or 57,000 generators, are devices which are not in compliance with specifications, and reports indicate that there have been approximately four accidents of unapproved generators to one of the approved machines. The reports also show that the total number of accidents compared with the large number of machines in use is very small and of this small number at least 70 per cent. were caused by gross carelessness, such as looking for leaks or thawing out a frozen pipe with an open flame against which no device can be protected if the user insists upon being careless. If you will consider that these generators are charged every month or so, the number of accidents is almost negligible.

FIRE LOSS FIGURES

Now as to fire losses—please note carefully that during the

calendar year 1920 property damage in this country resulting from the use of acetylene amounted to approximately $16,800, a loss ratio which would have practically no effect on the rate of insurance. To show you how very small this loss is, let us assume the average value of a home is $3,000, which is small enough as such things go nowadays. This would make a property value of $855,000,000 and with an 80 per cent. clause would represent an insurance value of $684,000,000. At 50 cents per $100 this would represent a premium income to insurance companies of $3,420,000 as against losses of $16,800, or approximately 49 per cent. It is obvious that even if our loss figures are very low, as stated to you, and if we assume it to be many times the figure given, it would be difficult to find a better risk from the standpoint of fire insurance.

It was endeavored to make these statistics absolutely accurate, and while the damage was estimated, in order that you may realize how thorough was the attempt at accuracy, it may be stated that the data was collected from the reports of no less than seven news agencies scattered throughout the United States, from the reports of several hundred salesmen, engineers, and others connected with the industry, and from the reports of fire marshals of 22 states; and right here for your information it may be stated that in newspaper reports of accidents and fires attributed to acetylene, there was no acetylene involved in nine cases out of ten.

Now let us consider a somewhat longer period than the calendar year 1920. Perhaps it is needless to repeat to you the figures covering the annual fire losses estimated by the National Board of Fire Underwriters which have averaged some $283,000,000 per year for the last five years and the first eight months of this year show positively that they are increasing greatly. To cover the unreported losses this figure is 25 per cent. larger than the amount actually reported and on which the tabulations are based. The amount actually reported has averaged $226,620,135 per year for the last five years. The average annual loss reported to the National Board from all gas causes, both natural and artificial, was $2,040,666, and the losses due to explosions of every kind for the same period averaged $2,032,429. This includes all the serious explosions and losses attributed to those causes during the period 1915 to 1919 inclusive, and to indicate the proportion of this loss attributable to acetylene, the following investigation was made.

ILLUMINANTS AS FIRE CAUSES

In the year 1915, one of the years covered by the National Board analysis just mentioned, a careful investigation was made of the data acquired by the fire marshals of the twelve States, viz., Connecticut, Illinois, Iowa, Indiana, Michigan,

Minnesota, South Dakota, Texas, Virginia and Wisconsin. Some very interesting figures were developed from these sources, which must be taken as the best available information. The records indicated that the four commonly used illuminants, kerosene, gasolene, electricity and acetylene caused 4,610 fires in these states, with a total money loss of $4,223,784. The total number of fires caused during this period from products of petroleum was 3,016, involving a loss of $2,081,955. The number of fires in the same period from electrical causes was 1,588, with a loss of $2,123,279. During the same period in the same states there were three fires caused by acetylene with a total loss of $9,275, thus making up the total fire loss from all these causes of $4,223,784. Briefly, the total number of fires due to acetylene was as 1 is to 1,536, as compared with the total fires from the four commonly used illuminants. The loss ratio of acetylene to all four illuminants was as 1 is to 454, and this with four states not recording the amount of losses, but counted in on the number of fires.

DANGERS FROM ACETYLENE

Kindly note that no particular states were picked in compiling this record, and these annual reports of the fire marshals from which the data were taken are required by law and addressed to the Governors of the various states. In other words, it is only reasonable to deduce from these figures that acetylene as the cause of fire losses is almost negligible as far as fire insurance companies are concerned, and this is practically the position taken by most of the large fire insurance companies. In fact, the National Board of Fire Underwriters, after considerable investigation of previous experience and records of losses by their engineers, decided that acetylene is safer than other illuminating methods which it commonly replaces, and also decided that installations inside of buildings as well as outside of buildings would be permitted under proper regulations providing for their installation and operation.

As to the comparative safety of this gas from the standpoint of lighting, I could quote you from many authorities, but in order not to take up too much of your time have limited these quotations to a very few from authors who cannot but have great weight with you as fire insurance people. The following is quoted from "The Handbook of Fire Protection," by Crosby-Fiske-Forster, all of whom are recognized authorities on fire protection:

"With a permitted generator (passed by the Underwriters Laboratories) and with the system properly piped, installed, and cared for, the hazards of acetylene lighting are not serious. Care should be taken that the calcium carbide is stored in a manner prescribed by the National Board Rules."

"Acetylene must not be compressed beyond 15 lbs. per square inch for any purpose unless by experienced persons and in properly constructed cylinders approved by the Interstate Commerce Commission."

"The extent to which acetylene gas is used for lighting purposes is seldom realized. There are over 250,000 installations in all parts of the country. In spite of occasional explosions, the fire record has been good, probably better than that of lamps or candles which acetylene replaces."

"The brilliant and pleasant light, the cleanliness, and the lack of seriously poisonous qualities are responsible for the popularity of acetylene."

There is a little pamphlet entitled "Fire Hazards on the Farm" published by the Farm Inspection Bureau of the Co-operative Fire Underwriters Association of New York State, which organization certainly has had intimate contact with the problem since carbide plants have been sold in New York State almost from the start of the industry. This pamphlet says of acetylene:

"Acetylene gas is a very satisfactory and economical light, and perfectly safe when properly installed. It is also very dangerous when carelessly installed by incompetent persons not familiar with standard requirements."

NATIONAL BOARD RULES FOLLOW

The industry stands squarely back of such advice. No matter how good a machine is, a faulty job of installation may create hazards, and the rules and regulations of the National Board of Fire Underwriters should be carefully followed. These two requirements, that is, standard construction and standard installation, are often made riders on fire insurance policies in order to be assured of the very best practice. The acetylene industry has been put on the basis of safety, which has been quoted to you, by co-operation with these institutions, and in presenting the case of acetylene to you I speak only for standard devices tested by Underwriters Laboratories and installed in accordance with the regulations of the National Board of Fire Underwriters for the Installation and Operation of Acetylene Equipment as recommended by the National Fire Protection Association.

Incidentally I may digress to mention that you are all individually, or as organizations, eligible for membership in the National Fire Protection Association, and thus for a nominal expense can be kept posted on the latest developments in fire protection.

Both the construction and installation regulations are revised from time to time as experience dictates, and when I have finished I trust you will agree with me that after ap-

paratus has been examined and tested by Underwriters Laboratories, and installed strictly in accordance with the National Board Rules, it has reached an acceptable degree of safety from a fire insurance viewpoint, and is safer than illuminants which it usually replaces, that is, candles, oil lamps and other portable devices which involve the use of inflammable liquids or the hazard of being pulled off of tables by children, dogs, or cats.

HAZARDS TO LIFE AND LIMB

Now, as to the hazard to life and limb. Although from a business standpoint, this would be of more interest to the casualty insurance companies, I am sure that you will be interested in a brief review of the situation if only from a human interest viewpoint. Fortunately in the development of the industry in the direction of fire protection, protection against accidents was afforded by the same safeguards. A recent analysis of statistics covering personal injuries indicates that there is much less occasion for anxiety, apprehension and distress in this direction than in many other branches of industry which we are accustomed to regard without special concern. In fact it is doubtful whether any industry involving moving parts, such as the usual tools and machinery, can be carried on year in and year out with as few accidents as this one. The reasons are obvious. So much special attention has been called to the hazards of acetylene, and so much careful and exhaustive study has been given to the subject, that its main hazards are recognized and proper protection afforded.

For comparison, let us imagine there is a group of 100,000 homes, each lighted with acetylene and each home having a family of five. This community of 500,000 people, which we will call "Acetylene City," would be comparable with Buffalo, Los Angeles, Milwaukee, Newark, San Francisco, Washington, or the Borough of Queens, New York City; in other words, a representative large American City.

We must compare acetylene with some similar hazard found in large cities, and for this purpose let us select the ordinary city gas which has become a utility so essential to our welfare that we hardly stop to consider the slight amount of attendant hazard which is so far outweighed by the benefits derived from the gas, which is an almost indispensable utility. In fact, no comparison which can be made at this time can militate against its well established position. In other words, there is no thought in the minds of those controlling the destinies of our cities with reference to abolishing anything about city gas except its price.

The accidents from city gas not resulting in death are not

available, but in the city of Chicago with a population of approximately two and three-quarter million, during the calendar year Dec. 1, 1919, to Dec. 1, 1920, the Coroner's records show the following deaths attributable to city gas, industrial uses 5; accidental deaths 199, deaths exact cause undetermined 41, suicide 127, homicides 3; total 375. Let us deduct the suicides as intentional deaths, leaving 248 accidental deaths, but at the same time let us point out that if these persons had lived in the "Acetylene City," they would have been compelled to purchase a gun or poison, or jump off a building, or kill themselves in some other way, as they could not have done it by inhaling their gas.

As the population of the "Acetylene City" was about 18 per cent. of Chicago's population, we would expect 45 deaths in the same period whereas my statistics show the proportion for the "Acetylene City" would for the year 1920 be only four. As we find only four deaths, it would appear that acetylene with the safeguards thrown around it is some ten times safer than might reasonably be expected.

A similar comparison was made with New York City covering the last three years. For some reason or other the proportion of suicides in New York seems to be greater than in Chicago, but without considering the suicides we still have a ratio of four accidental deaths from acetylene to between 37 and 38 per year in New York, always figuring it back to the basis of 500,000 population, which is the size of our supposed "Acetylene City." Nevertheless, as you will know for some reason or other when there is an explosion of acetylene it is very widely advertised.

FUEL OILS

A Study of Flash Points of Volatile Oils—Proposed Limitations of Storage—Conditions at Sea and on Land

By Dr. Van H. Manning

When the American Petroleum Institute held a conference on fire prevention and protection to life and property, Dr. Van H. Manning, director of research for the Institute, made the following statement concerning the flash point of fuel oil:

Flash point is of importance in establishing the relative explosion hazards of volatile inflammable products. It is of particular interest to the oil industry as limiting the amount of storage and restricting the use of petroleum products. The subject of flash point vitally affects the use of fuel oil.

There are existing or proposed limitations on the storage of fuel oil having flash points below 150 degrees Fahr. It has been brought to the attention of the American Petroleum Institute that such limitations if rigidly enforced would seriously handicap the use of a large percentage of California and Mexican crude oils which in the past, due to their small light oil content, have been used, untopped, for fuel purposes. It is of interest to note too—judging from many replies gathered in the past two years that the 150 degrees Fahr. limitation if rigidly enforced would seriously affect the fuel oil output of many refineries in the Mid-Continent and Eastern Districts.

On the Pacific Coast some 30,000,000 barrels of fuel oil are consumed annually, most of it having a flash point below 150 degrees Fahr. (closed cup) and some of it having a flash point even as low as 90 degrees Fahr. The greatest part of this crude oil has a flash point ranging from 110 degrees Fahr. to 130 degrees Fahr. particularly the fuel used by the railroads, most of which has the lower value of 110 degrees Fahr. open cup. I am quoting from a reply of the chief chemist of the Atchison, Topeka & Santa Fe Railway: "You will note we only require a minimum flashing point of 110 degrees Fahr. when using the open cup. The closed cup gives with oil of this grade some 20 degrees lower flash point than the open cup so that the discrepancy between the (N. F. P. A.) requirements and ours is about 60 degrees Fahrenheit."

I am reliably informed that in Los Angeles over 95 per cent. of the apartment houses, office buildings, bakeries and

similar establishments have been using a fuel oil (a so-called "Stove or Furnace Distillate") having a flash point between 100 degrees and 120 degrees Fahr. In that one city alone over 160,000 barrels of this fuel were used in 1919. Local ordinances permit a fuel oil flash point of 110 degrees Fahr. closed cup in both Oakland and Los Angeles and of 90 degrees Fahr. in San Francisco. The fire marshal of San Francisco reports: "There has been no fire of any consequence from crude oil as installed here. At the time of the earthquake and conflagration here in 1906, there were 118 oil installations in the burnt districts; there were no explosions and when the ruins cooled everyone was found intact." It has been stated that during the past thirty years the fire loss in California attributable to the use of fuel oils would not exceed $50,000.

COST OF TOPPING CRUDE

One-third of the fuel oil used in California is crude oil. This oil as to gasoline content is comparable to Panuco crude containing a maximum of 3 per cent. gasoline and as low as 1½ per cent. Refinery residium contains a maximum of ½ of 1 per cent. of gasoline down to a minimum of 0 per cent.

It has been stated that to top this crude oil, in order to bring the flash point up to 150 degrees Fahr., would require an outlay of some $20,000,000 and would add $1,800,000 annually to the cost of fuel on the Pacific Coast.

Until economic conditions and developments in the art of refining make desirable and possible changes in the utilization of the present crude oils there will remain true the relation that whereas only 20 to 50 per cent. of the bulk of Eastern, Mid-Continent, Rocky Mountain and Gulf coast crudes represent the heavier fuel oil and gas oil components; in California, the fuel oil and gas oil fractions represent about 67 per cent. of the bulk of the crude. Furthermore during 1921 the California output of fuel oil constituted fully 26 per cent. of that of the entire country.

I have been trying to establish the origin of the fuel oil flash point limitation set at 150 degrees Fahr. It is possible that when the fire regulations were first adopted the agencies responsible for these regulations used the flash points established by the United States Navy and of Lloyds, both of whose standards are based upon very severe and highly special conditions encountered only at sea.

In the course of my investigation I consulted Dr. C. F. Chandler, who as early as 1867-1868 established a safe flash point limit for kerosene in the metropolitan district of New York, and whose classic flash point investigators extending even into European countries were the basis of establishing the first laws and ordinances regulating the sale of kerosene.

Dr. Chandler was unable to state why the flash point limitation of fuel oil was set at the figure of 150 degrees Fahr.

I corresponded with Admiral Griffin of the United States Navy, whose supervision of the Bureau of Steam Engineering dates back before the days of the use of fuel oil in the navy. Admiral Griffin was unable to state how the limitation of 150 degrees Fahr. for fuel oil became established in the navy and referred me to his successor, Admiral Robison, with whom I then took up the matter.

CONDITIONS IN UNITED STATES NAVY

Admiral Robison replied that naval vessels must be in readiness to proceed to the tropics at all times; that the firing of guns subjected such types of vessels to dangerous conditions to which other types of vessels are not exposed; that on account of the numerous transverse bulkheads and a protective

A BAD OIL TANK BLAZE

deck, and the crowding of machinery and boilers, it is rather difficult to ventilate certain compartments; that, in fact, each naval vessel is a floating arsenal; all of which created the necessity of taking extra precautions to prevent fires or explosions of any description and, therefore, the navy con-

sidered it inadvisable to lower their flash point requirements below 150 degrees Fahr. This is the nearest I have been able to come to a scientific reason for a flash point limitation of 150 degrees Fahr. and, of course, you recognize the very special conditions underlying the above reasoning as affecting the use of fuel oil at sea.

FLASH POINT DEFINED

I also took up the matter with Mr. Butler, of *Lloyds Register*, who was kind enough to send me copies of the only material available to him, namely, a report by Professor Brame, president of the Institution of Petroleum Technologists of Great Britain, from which I quote the following:

"Flash point is that temperature to which oil must be heated to give off vapor in sufficient amount to form a mixture with air which can be ignited by a flame.

"The flash point is, therefore, not a measure of the risk of fire, but of the risk of explosion, which, although it may be disastrous, will not lead to a fire unless the oil has been heated above its ignition point before the vapor-air mixture is ignited.

"Ignition point on heating (referred to by other writers as the fire point) is the temperature to which the oil must be raised before it continues to burn in the open testing cup after application of the test flame (fire test). This is referred to in the trade as the 'burning point.'

"It is approximately the temperature to which at least the surface layers of any accumulation of fluid oil must be raised to start a fire.

"From data of a large number of high-flashing oils (mostly 'lubricating' of, say, 200 F. or over) the 'burning point' ('fire test') is some 60 F. higher than the closed flash point. With ordinary 'fuel oils' the difference is ususally less—say 35 to 45 F.

"Spontaneous ignition temperature is the temperature to which a metal cup must be heated, so that oil falling slowly drop by drop into it will form a mixture with oxygen or air which spontaneously ignites—i. e., without the application of a naked flame.

"Approximately this is the temperature at which a boiler casing or other metal surface must be for ignition to take place of an oil spray from a broken pipe or leaking joint, providing, of courses, that the oil vapor is not ignited by some flame to which the vapor finds access.

"Although strictly there is no direct connection between *flash point* and the risk of fire, yet it is a relative measure of *safety in use of* any oil in spaces where there are exposed *lights, flames or other* means of ignition, and, therefore, cannot

be set on one side in favor of the 'fire test,' although the latter is more specifically connected with the fire risk."

Prof. Brame also stated that on account of the difficulties involved in making determinations of fuel oil flash points on shipboard and the needs of extreme caution applying to a marine hazard, "the chief engineer should be called upon to ascertain that the oil does not flash below 150 degrees Fahr."

I communicated with Dr. John A. Harker of the Ministry of Munitions, London, England, who has directed divers researches at the National Physical Laboratory, in conjunction with W. F. Higgins, on flash point determinations. Dr. Harker spent some considerable time in searching through the likely sources for a history of fuel oil flash point regulations and he is "surprised to find how little information is given in the literature."

I have requested information on this subject from Dr. S. W. Stratton, director of the United States Bureau of Standards, who replied on March 11, 1922, as follows:

"There appears to be need of an investigation relative to fire hazard of fuel oil as due to flash point."

He also was unable to give me any suggestions as to how the limitation for fuel oil was established at 150 degrees Fahr.

DIFFICULT TO RATE ALL OILS

I directed my inquiry to the United States Bureau of Mines and received a reply to the effect that this bureau is not in possession of information that would enable it to suggest a minimum flash point that would embody all of the fuel oils of the United States.

Inquiry was made of Professor R. E. Wilson, director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology. He stated he could see only three possible bases for a flash point specification on fuel oil, as follows:

1. Keeping the specifications high in order to prevent waste of gasoline by leaving it in the fuel oil.
2. A specification required in order to make the stuff behave properly in ordinary oil-burning equipment.
3. A specification to insure the absence of danger from explosions in storage tanks, etc.

He further stated that outside of the first two bases the flash point "temperature should be fixed to bear a reasonable relation to the maximum temperature which the oil would be subjected to during storage. On ships, with their cramped quarters and poor ventilation, it is conceivable that temperatures around the oil storage tanks might rise so high as to necessitate a specification of 150 degrees Fahr. * * * but I cannot conceive of any likely condition of fuel oil storage for indus-

trial use where temperatures would rise appreciably above 100 degrees Fahr. It would, therefore, appear to me that a closed cup flash point specification of 115 degrees Fahr. would afford an entirely reasonable factor of safety against all ordinary uses."

I also directed my inquiry to Underwriters Laboratories and received their reply to the effect that they have practically no data covering the flashing points of fuel oils.

REVISION EXPECTED

I am greatly encouraged in the belief that the flash point limitation, as applying particularly to fuel oil, is about to receive the thorough consideration which the importance of the subject merits and that before long a flash point standard will be established which will not be discriminating and unreasonable for the oil industry and which will at the same time maintain the protection of property and life against any undue hazards in this connection.

It is of interest to note that the subject of flash point is receiving an increasing amount of attention and a close scientific connection has been established rather recently between the volatility of various materials and their flash point temperatures. I am referring now to a paper entitled "An Investigation into the Physio-Chemical Significance of Flash Point Temperatures" appearing in the April, 1922, *Journal of the Institution of Petroleum Technologists,* London, England. An earlier paper by W. Paymann, appearing in the November 15, 1918, issue of the *Journal of the Society of Chemical Industry,* and entitled "The Danger of Explosion with Inflammable Liquids and Vapors" also touched upon this relation.

Flash point in the past has been regarded more as an empirical figure rather than a true physical constant, largely because the greater part of the work done in the past has centered around the flash point of a complex mixture such as kerosene. Largely because of this empiricism the research in this field seems to have been neglected until quite recently.

It would appear obvious that a knowledge of the flash point temperature and of the vapor pressure would give an indication of the composition of the vapor at the limits of flame propagation both for the upper and for the lower explosive limits.

It would seem that deductions made from reliable data would have practical application to the automotive industry particularly as regards carburetor action and and in internal combustion engines and I am confident that a great impetus is now being given to the study of this important relation.

ELECTRIC PRESSING IRONS

Conditions Prevalent in Cloth Industries and in Dwellings; Results of Tests; Specifications for Stands.

By W. J. Tallamy, Chief Inspector, America Fore Companies, New York

About fifty years ago a man named Fitchbury invented a self-heating pressing iron. This iron was a somewhat crude object of the reversible type, in which both top and bottom could be used as a pressing surface, one side being heated while the other was used. It was a gas-heated iron, the burner extending through the center, with flame shooting upward against the bottom of the upper surface. It appears to have been the original self-heating pressing iron from which many others were developed, until finally the modern gas-heated pressing iron of today was perfected.

Shortly after this iron was patented in 1874, electrical engineers realizing the commercial possibilities of self-heating pressing irons began to experiment with electricity as a heating medium. During 1882 Henry W. Seely produced an electrically-heated pressing iron which was destined to lead in revolutionizing the pressing iron industry.

NO. 1. EFFECT OF LEAVING HEAT ON

It is usual to find electric pressing irons supported by a single sheet of metal resting on fabric covered pressing boards. This picture shows what is likely to happen if the iron is left in service. In this case, smoke was seen issuing from below the edges of the sheet metal stand. Within a few minutes the smoke was followed by flames.

It took many years to educate the public to the commercial advantages of the self-heating pressing iron, but since this began to show accomplishment about twenty-five or thirty years ago the increase in their general use has been rapid.

From the beginning, however, dangers attending use of these irons have been grossly underestimated.

When these men presented to the world the self-heating portable pressing irons which have in a short time become an important factor in cloth goods manufacturing establishments and in the home, they little dreamed that these instruments designed solely for economic purposes would ever become one of the most destructive of modern inventions. Their simple and harmless appearance seems to have totally blinded the public to their hidden dangers.

NO. 2. GARMENT FACTORY HAZARD

Pressing bench conditions as frequently found in garment factories. The stand on which the iron rests is one of the safest now in use, but its sharp edges have cut through the fabric covering of the pressing board making it possible for the covering to loosen and extend over the bottom flange of the stand coming in contact with the iron in places. The fabric covering has been heated almost to the point of ignition in a number of places.

Few people realize that the self-heating pressing iron is practically a small portable furnace, the surface of which is capable of heating to a temperature equal to that of other types of furnaces. Its use and installation has never been restricted or governed by municipal ordinance, its safety being left entirely to the judgment of users, most of whom have little or no knowledge of its dangerous nature. In many respects it is even more dangerous than the heating furnaces, inasmuch as its surface will heat to a dull red in a comparatively short time unnoticed.

Everybody knows in a general way the destructive possibilities of fire and that furnaces, if set in contact with combustible material may sooner or later result in fire. Therefore persons in all walks of life are constantly on the lookout to prevent the existence of such conditions, and yet there is hardly a user of the portable self-heating pressing iron who *does not* unhesitatingly from time to time allow it to rest *directly on unprotected* fabric-covered pressing benches and *other combustible* material.

It is roughly estimated that over 15,000 people perish by fire in the United States every year and that a greater number are maimed for life by the same cause. It is well known that the annual irretrievable property loss by fire now averages between $350,000,000 and $500,000,000.

Over 30,000 of these fires are started by the self-heating pressing iron; a startling fact when we pause to consider that in nearly all the modern homes equipped with electricity, and many that are piped for gas, there lurks this fire hazard not properly safeguarded.

The writer has been studying the pressing iron hazard for some time, searching for the causes of fires as they occur and for conditions that lead to and contribute toward starting these fires, and has come to the following conclusions:

1. That properly built gas and electric self-heating pressing irons under proper care and when provided with proper safeguards are perfectly safe and harmless.

2. That practically all the fires that result from the use of self-heating pressing irons are directly or indirectly due to carelessness and indifference on the part of the users.

3. That fires of this origin usually start with the ignition of inflammable material under or at the sides of the iron, frequently because the iron rests upon unsafe and improperly installed supports, as in first picture.

4. In order to successfully cope with the hazard of carelessness and negligence in the use of pressing irons, it becomes necessary to apply remedies that operate automatically. This is only possible with the electric pressing iron, which can be equipped with an attachment that *will at a given temperature* (not

NO. 3. HEAT ON FOR SEVEN HOURS

One of the best pressing iron stands in use, but even it is unsafe without a metal-covered ¼-inch asbestos shield below as is shown by the following experience: An electric pressing iron was placed on this stand and allowed to remain in service several hours. After about 7 hours the current was shut off and the iron and stand removed. The result is shown in illustration 4.

over 600 deg. F.) cause the electric current to be shut off automatically. Immediate steps should, therefore, be taken to have all electric pressing irons equipped with approved heat controlling devices before they leave the factory.

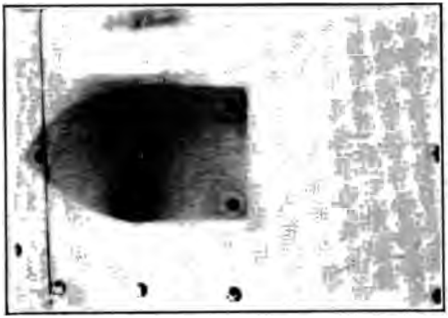
5. That the quickest and surest way to bring about immediate relief from the loss resulting from this hazard in connection with all gas and nearly all electric irons now in use lies in the adoption and constant use of a more or less foolproof iron support; one that will resist the heat from the iron, effectively preventing it from igniting inflammable material on which the stand may rest, at the same time having a tendency to prevent any combustible material that may be at the side of the stand from coming close enough to the iron to permit it to heat sufficiently to ignite.

In co-operation with the engineering departments of the New York Fire Insurance Exchange and New York Board of Fire Underwriters, a careful investigation of the merits of stands now in common use and generally accepted as safe, was made, but none were found to measure up to these requirements. One difficulty common with the previously approved cast-iron stand with 3-inch legs was that the open space between the legs permitted inflammable material to collect directly under the iron, such as lint, lunch papers, boxes of matches, pieces of fabric, etc., in many cases banking up close to the surface of the heated iron. Constant use of these stands gradually caused the legs to cut through the fabric and padding cover on the pressing bench, causing the covering directly under the stand to work close to the surface of the pressing iron.

This also occurred in use of the various types of iron supports now furnished with electric irons, except those known as "double deckers" having metal guards under the iron which prevented inflammable material from collecting there, but did not prevent its coming in contact with the sides of the iron. (See illustration.)

That none of these stands are entirely safe was shown in a test with an electric iron resting on a treble deck stand, shown in picture No. 3, generally considered the best and safest stand in use. After about seven hours had elapsed the heat from the iron was found to have charred the fabric pressing bench covering almost to the point of ignition, as is shown in picture No. 4.

Improved stands were made and subjected to severe tests until finally one has been selected that will not only stand up satisfactorily under working conditions, but one that will, if conscientiously used, do much to offset the carelessness and indifference now so common on the part of pressing iron users. A view of this stand is shown in the picture following.



NO. 4. BURNED THROUGH ALL DECKS

The heat from the iron was transmitted through the stand, notwithstanding the air spaces between the metal sheets, causing the fabric bench covering to heat and char almost to the point of ignition.

Stands. Whether irons are heated by gas, electricity or otherwise, approved stands for the irons must be provided. A good type of stand consists of four parallel sheets of No. 20 gauge or heavier metal, securely riveted together so as to leave ⅝ of an inch air space between the upper plate and the one below it, the same space between the latter and the one below, and a ¼-inch space between the lower plates. The latter space is to be occupied by a ¼-inch sheet of asbestos millboard, the edges of the two lower sheets to be crimped or otherwise fastened together so as to retain the millboard. The upper sheet is to be slightly larger than the pressing iron and have front and sides turned up ⅜ of an inch so as to prevent the pressing iron from slipping; the sheet below this to be approximately the same size as the upper sheet, but the two lower sheets, containing the millboard, to extend an inch beyond the other plates on all sides. At least five rivets are to be used in the *construction of the stand of*

NO. 5. BEST TYPE OF STAND FOUND

Improved pressing iron support which effectively protected inflammable material under and at sides of iron, preventing it from heating to a dangerous degree during severe tests lasting several hours.

ordinary size. For stands for larger or heavier irons, the number of rivets must be increased to make a stand sufficiently strong that there will be no danger of its being crushed by the weight or impact of the iron. Any equivalent stand will be accepted.

While this stand has not as yet been approved by Underwriters Laboratories, the urgent, immediate need of improvement over existing conditions prompted its adoption, or the equivalent, as a standard by a number of local insurance engineers. It is one of the safest stands prescribed up to the present time. Pending the approval of this or a similar stand by Underwriters Laboratories every effort should be made to safeguard this hazard. The improved stand or its equivalent can be readily made by any competent sheet metal worker. Any modern ordinary stand of the double deck type can readily be made safe provided the iron supporting member is at least one inch above the base, by fastening sheet metal 10 or 12 inches square, one sheet over the other, under a block of asbestos the same size and ½-inch thick, all to be carefully riveted together. The pressing iron, however, must invariably rest upon the stand while connected and not in actual use.

A great deal of reliance has been placed upon the presence of a red pilot light intended to indicate whether the current is on or off, as a safeguard where electric pressing irons are in use. It is not uncommon to find that pilot lights do not show when the current is on because the lamps have been discarded on account of broken filament or other defects, an indication of the weakness of this safeguard.

INTERNAL COMBUSTION ENGINES

Steadily Increasing Use of This Type Necessitates More Careful Study by Underwriters and Engineers

By E. C. Hach, Engineer, Chicago, in Fieldmen's Manual

Back firing is due to the fact that the incoming charge of gasoline and air or kerosene and air is set afire and the mixture explodes back in the carburetor. So long as we depend on the incoming air to draw in the fuel on its way to the cylinder we will have an explosion mixture in the intake pipe. When back firing occurs the flame and excess gasoline in the carburetor are blown back into the room, thus presenting a very serious fire hazard.

Back firing may be due to a slow burning mixture, usually a very lean mixture. A very lean mixture is slow burning and hangs fire for some time, in fact until the intake valve opens, when the flame in the cylinder sets fire to the new incoming charge and the flame is carried back through the intake valve which is open at the time.

It may also be caused by deposits of carbon in the cylinder that have become and remain hot, setting fire to the incoming charge. Engines burning kerosene are likely to be troubled with carbon deposits formed by incomplete combustion or cracking of the fuel.

Another cause of back firing is a leaky intake valve. If the valve does not hold tight against the explosion pressure, hot flame or gas will shoot back into the mixture just outside the valve, setting it afire and causing back firing.

Back firing cannot occur in a Diesel or Semi-Diesel engine if the injection pump is properly adjusted so that fuel will not be injected into the cylinder until the proper time for combustion, and if this adjustment is not properly made the engine will not run.

FIRE HAZARDS

The hazards from Internal Combustion Engines may properly be divided into two general classes:

1. Inherent hazards from the engines themselves which are largely determined by their construction and installation and which are not under the direct control of the operator.

2. Handling of the fuel and care of the equipment.

The latter is under the direct control of the operator, and *as such the human* element enters in and consequently this

hazard is of primary importance. Our regulations governing the installation of engines were promulgated to guard against these hazards and the construction and installation has been fairly well standardized; but the fuel is handled by the operator and careless handing of fuel has probably been responsible for more fires than the inherent hazard of the engine itself. That particular point should, therefore, be carefully investigated by the inspector.

We will discuss first, inherent hazards common to all types of engines, and then take up hazards of certain types of engines.

All types of Internal Combustion Engines present the hot exhaust pot or exhaust pipe hazard. Exhaust temperatures will vary from 300 degrees to about 1,400 degrees F. Iron becomes red hot at about 1,000 degrees F. It is plain to be seen that combustible material should be kept clear of an exhaust pot or exhaust pipe. The inspector should see that no oily rags are left lying around for they are very liable to spontaneous combustion, especially where there is a source of heat to stimulate the chemical action that results in spontaneous combustion. Several fires have come to our attention recently that were caused by combustible material having been set on fire by an exhaust pot, and in these cases the combustible material was about 2 feet from the exhaust pot. Our regulations at the present time require a clear space of 1 foot, but it is always well to have more if it can just as well be had. Where an exhaust pipe passes through a combustible wall it should have a clear space equal to at least 1½ times the diameter of the exhaust pipe and a ventilating thimble should be provided.

Another quite frequent occurrence which presents a very serious hazard is the burning out of the exhaust pot or pipe. This is perhaps more common on the engines which burn the lower grades of fuel than to engines burning gasoline. When the lower grades of fuel are burned they sometimes crack and the excess carbon may be burned or it may not, but more frequently not, unless the engine is running on very light load and has a great excess of air in the cylinder. This carbon will deposit in the exhaust pot or pipe and eventually burn out. For this reason a stack should never extend through the roof, especially where the roof or building is combustible. There is in variably chaff or a caked grain dust on the roof and a hot flake of carbon would start a fire very easily.

It also happens sometimes that a mixture is not ignited and passes out of the cylinder unburned. If this happens when the the engine is being started and ignition fails several times in succession, a considerable quantity of combustible mixture will accumulate in the exhaust pot or pipe or in the exhaust

pit if one is using and then when the engine does start and hot gases are exhausted they may set fire to the unburned gases. If this passage to the atmosphere is at all restricted by elbows, long pipes, etc., the pressure due to the combustion of these unburned gases may rise to a point which will blow up the container in which the explosion takes place. To avoid this condition the exhaust pipe should be carried to a non-combustible exhaust pit, built to resist an internal pressure of 50 lbs. per square inch and provided with a stack at least one nominal size larger than the exhaust pipe. It should also be provided with a manhole bolted down to resist the specified pressure. Stack should always be outside of the building.

Occasionally a fuel pipe will leak or break off at a joint, due to the crystallization of the metal caused by the constant vibration of the engine. The Inspector should examine the suspension of these pipes and see that there is no place where a pipe may be fastened to something rigid such as a wall, at a point very close to where it is fastened to the engine so that the vibration of the engine will bring a strain on the joints.

MOST HAZARDOUS TYPE

The carburetion engine is more hazardous than any other type. Back firing through the carburetor and into the room is a very serious hazard. Kerosene carburetion engines are usually started on gasoline and when they are warmed up they are switched over to kerosene. This is accomplished in a number of different ways which are safe, but occasionally an operator will remove the spark plugs and "prime" the engine by squirting a little gasoline into the combustion chamber. In doing so he may squirt gasoline on the outside of the engine and thus introduce a hazard. Even that method is too slow for some and they warm up by burning gasoline on the outside of the cylinder or build a fire under it. Such a practice is, of course, inexcusable. In such cases the inspector should either convince the operator of the error or relieve his company of liability.

There is one very objectionable feature to the Semi-Diesel engine. It is necessary to heat the hot bulb before starting. This is usually done with a gasoline torch and therein lies the danger. The bulb itself is usually protected by a cap and though there is still some element of danger, even when so protected, it is not regarded as serious. The hazard is in the handling of the torch and since that is handled by the operator he is the man to talk to. Ask him what precaution he uses. *Discuss the* subject with him and impress him with the *necessity of carefully* handling it.

TANKS FOR FUEL

The hazard in connection with the handling of fuel depends upon the kind of installation. If tanks and piping are installed according to our specifications for a pump feed arrangement, practically the only thing that can present a hazard is the breakage of pipes. Even a gravity feed arrangement for compression ignited engines is safe if it is installed strictly according to our specifications. Gravity feed for electrically ignited engines is not permitted. Electrically ignited engines are carburetion engines, and the fuels they burn vaporize very readily. In gravity feed arrangements the carburetor is equipped with a float so that the fuel is automatically shut off when the carburetor contains a certain quantity. This float may fail in its operation or pipes may break and thus permit the entire contents of the feed tank to flow into the room. Since this type of engine burns either gasoline or kerosene, such a condition would be very serious. A compression ignited engine, however, does not have a carburetor and, therefore, such a condition is not possible. The only thing that could happen in the latter case is the breakage of a fuel pipe, and since our specifications for a gravity feed arrangement require fuel pipes to be enclosed in larger pipes that will drain to a trench or conduit which in turn will drain to a pit located outside the building, this hazard is also eliminated.

Engines that are not installed according to our specifications may present a hazard. If the tanks are filled by hand in the building, fuel will invariably be spilled on the floor and therein lies the hazard. This is the hazard of the tank in the base, and where the engine is located in a dirty place the hazard is sufficient to warrant declining to recommend the risk.

When storage tanks are located above ground or underground and not as deep as required by our specifications, a direct cocnnection between the storage tank and feed tank were accidentally left open after filling the feed tank, the level of the fuel in the storage tank may be high enough to cause the fuel to feed by gravity past the feed tank and into the engine room. This may not be a hazard at the time the valve is left open and when the operator sees that the engine will operate with that valve open he may leave it open at all times to save him the trouble of filling the small tank so often. Eventually the pipes may leak or break and then this condition becomes a hazard.

PIERS AND WHARVES

Conditions Surrounding Large Municipal Project in New York; Structures Not Modern; Discussion of Wharves in General

*By William B. White, Chief Inspector, Survey Department, New York Board of Fire Underwriters.**

There are perhaps no fire risks that are less standardized than piers and wharves. This is to a large extent incident to the own-

Photo by Underwood & Underwood

DESTRUCTION OF PIER 5, HOBOKEN

ership. Most of our piers and wharves are owned by the municipality and suggestions for fire protection are not very well received. The departments having jurisdiction believe that they are spending public money for improvements and that they must be built so that a revenue may be expected, sufficient at

* Delivered in Insurance Institute Lecture Course of Insurance Society of New York.

least to pay the interest and mature the bonds floated for the purpose. Another factor is that in suggesting sub-division by fire resistive walls, the steamship companies are not disposed to rent piers and wharves so subdivided in competition with piers that are not subdivided, on account of interfering with the rapid and economical handling of cargo. In fact there are instances where the subdivided structure is used only when other space is not available. Naturally a pier or wharf is not a profitable venture under these circumstances.

The fire record of piers and wharves is bad and there is ample justification to urge adoption of fire protection measures in construction, subdivision of areas and fire protection appliances.

In starting our discussion, it might be well to define briefly the more important units of the pier and wharf and the structure.

TYPES OF PIERS

Pier: A pier is a platform of timber, stone or other material on supports projecting from the shore into a navigable stream or harbor so that vessels may be moored alongside for loading and unloading, or for storage.

Wharf: A wharf is a platform of timber, stone or other material built on supports along and parallel to a navigable stream or harbor so that vessels may be moored alongside for loading and unloading, or for storage.

Slip: A slip is a dock having a natural open basin; it is the space between two adjacent piers.

Bulkhead Wall: A bulkhead wall is a retaining wall of timber, stone or other material built along or parallel to a navigable stream at the shore end of a slip.

Pile and Deck Type of Pier: The pile and deck type of pier is one having substructure of piles or ordinary timber, steel, or concrete, or of concrete columns extending to the pier deck and, in the case of concrete construction, may have the piles terminate in the pier deck as a part of the deck system of construction.

Pile, Platform and Deck Type of Pier: Consists of a substructure of piles or ordinary timber, steel or concrete, or of concrete columns carrying a platform at low water and the pier deck supported on columns extending up from the platform, or bridge walls may be erected on the platform to support the pier deck and a retaining wall may be built around the platform; the enclosed area may or may not be solidly filled with incombustible material.

Block and Bridge Type of Pier: In this type of pier the substructure consists of blocks of concrete or stone or, as is frequently the case, of timber crib work, resting on the bed of the river or harbor. On these supports are constructed cross walls or arches of concrete, steel, stone or wood, which carry the pier deck.

Solid Fill Type of Pier: The substructure of this type of pier consists of a retaining wall forming the sides and outer end, with the enclosed area filled in.

Fire Bulkhead: A fire bulkhead is a tight sheathing or siding of heavy planks or reinforced concrete, constructed on the outside of the pier, or, if there be a deck platform, on the outside of the deck platform between high and low tide. In the case of wood structures, the sheathing is never made tight at the pier deck so as to prevent free circulation of air. The fire bulkhead is intended to prevent oil and floating fires from passing under the pier.

Substructure: The substructure is that portion of the construction below and including the pier deck.

Superstructure: The superstructure is that portion of the construction above the pier deck.

Substructure Columns: The substructure columns are large cylindrical uprights, used instead of piles, usually constructed of reinforced concrete ranging to 10 feet or more in diameter. They may rest on the harbor bottom, or on a base, or on a cluster of piles.

Bulkhead Line: The bulkhead line is the line established in navigable streams and harbors by the Secretary of War or in the absence of Federal control, by local authorities, beyond which bulkheads and piers of the solid fill type cannot extend.

Pier Head Line: The pier head line is the line established, in navigable streams and harbors, by the Secretary of War, or in the absence of Federal control, by the local authorities beyond which piers and marine structures of any kind cannot extend.

CONSTRUCTION NOT MODERN

Piers and wharves are the connecting link between land and water transportation. Primarily their function is to furnish shelter to vessels, stability during the loading and unloading, capacity for storing and classifying freight, means for the quick and economical transfer of freight to vessels, cars or vehicles and facilities for passenger traffic. Conditions as they exist today indicate that the thought applied to design and construction has not included modern methods of safeguarding the fire hazard except in a comparatively few instances. The elements that have exerted great influence on pier construction are the desire to satisfy the wishes of the lessee, to design structures that can be built and repaired quickly and at comparatively cheap costs, and which will result in a reasonable life for the structure and still provide service. Numbers of piers are constructed with open wooden piling, ordinary wooden decks, ordinary wooden sheds or sheds with unprotected steel framing with corrugated iron siding, large unbroken areas ranging from an approximate minimum of 30,000 sq. ft. to an approximate maximum of 200,000 sq. ft., and their

are instances where even this maximum is exceeded. The term "shed" applied to the superstructure is, in most instances, truly descriptive. There are, of course, piers and wharves that cannot be described in this way. Pier properties, as stated before, are the connecting link between land and water transportation and there is ample justification for urging the need of applying modern principles for safeguarding the fire hazards. These properties can easily contain cargoes ranging in value as high as several million dollars and have berthed along side at time vessels that cost many million dollars, mutually exposing one another. It is true that bottom and harbor conditions, in some localities, prevent more substantial and permanent structures, but even in these cases the safeguarding of the fire hazard has not been given proper consideration. Deep and soft bottoms limit the length, size and number of piles and have an important bearing on the structure that can be erected. Piling is subject to attack by worms and marine animals and careful consideration must be given to the protection of such piling and their replacement and to use a substructure least subject to attack. Also in tidal waters, that portion of the wood that is above half tide is subject to decay. Flexibility and elasticity are required in locations exposed to the movement of waves and swells, for if the pier is rigid and no provision is made in the deck platform for absorbing the shock of vessels, either the hull of the vessel or the pier must suffer. Again, it is most important not to obstruct the free flow of water, ice and sewage. Access to piers for the land fire-fighting forces is poor, being confined to one narrow end, and the marine fire-fighting equipment, except in some of our largest ports, is none too good and subject to delays incident to weather conditions. Fires on piers are likely to spread very rapidly, due to their combustible contents and unbroken area and sheds of unprotected structural steel and sheet metal collapse very quickly, and delay in the fire-fighting forces will probably mean that the fire is impossible of extinguishment.

NEW PIERS AT STATEN ISLAND

The largest pier development yet undertaken by the City of New York as a unit and at one time, are the new piers now nearing completion along the Tompkinsville and Stapleton water front of Staten Island. This important improvement comprises twelve piers, numbered 6 to 13 inclusive and 15 to 18 inclusive, at which large ocean-going vessels can load and unload in the deep water slips. The cost is about 20 million dollars. These piers range from 1,000 ft. to nearly 1,200 ft. in length; eight averaging 125ft. in width, two 130 ft. in width and two 209 ft. in width. Four are double-decked and eight are single decks; two of the double-deckers having mezzanine office floors at the shore end. The average width of slips between the piers is about 300 ft.

The bulkhead line is of reinforced concrete and the area beyond is now being filled in with earth and refuse. The substructures consist of wooden piling carrying wooden girders which support decks constructed of 10-inch reinforced gravel concrete and a 2-inch asphalt block flooring. There are three cross fire-bulkheads to each pier, consisting of 6-inch reinforced gravel concrete from high water mark to the underside of the pier deck and 4 x 10-inch planking between low and high water marks; each section being accessible through four manholes from the pier deck.

The superstructures are constructed throughout with steel framing. The shore and water ends have corrugated iron sheathing on steel framing and door openings with manually operated steel rolling doors 18 to 20 ft. wide and 20 ft. high, except in a few instances the Ogden type of door is used. Sides of piers consist of continuous cargo doors of single corrugated iron sheets rivetted to angle iron framing, double leaf type, manufactured by Ogden, and the upper leaf in most cases contain wired glass panels. Doors are manually operated (can be operated by one man and take about five minutes to open or close). Openings are 18 ft. wide and 20 ft. high and hinged dwarf or smash doors 4½ x 5 ft. are provided on each side of each pier at intervals of about 150 ft. Exception is made in piers numbered 12 and 13, where the doors are constructed of one-inch tongued and grooved boards, battened on the inside and covered on the outside with corrugated iron, nailed with nail heads exposed. These doors are 20 x 20 ft. and slide horizontally on tracks on the outside of the pier structure (tracks hooded) are manually operated and it is difficult for one man to operate. Hinged dwarf or smash doors 2½ x 4 ft. are installed at intervals of about 150 ft. on each side of pier. The space between each door is about 20 ft. in width and the construction is corrugated iron on steel framing. Roofs are 1½-inch plank covered with 5-ply tar and gravel roofing and supported on steel trusses and two rows of interior steel columns. Skylights are 5 x 10 ft. each, glazed with thin ribbed glass in metal frames and number about 100 in each roof.

The second floors of Piers 12, 13, 15 and 16 are five-inch reinforced gravel concrete arches with 2-inch asphalt block flooring on steel beams 4 ft. 7 inches on centers on steel girders and 2 rows of interior steel columns. Steelwork throughout on all piers is *unprotected*. Elevators in the double deck piers are enclosed in four-inch tile block shafts (some shafts not yet erected), extending to the roof and glazed with thin glass skylights; openings without doors at present. The elevators at the shore end are to accommodate trucks and are very large. Spiral stairways (two) to each double decker connect the first and second floors of the piers proper, trapped by manually operated traps; the

main stairway (at shore end) is open. Offices are located on the shore end, in some instances also at the river end, and consist of wooden boards on wood studding, covered both sides with stamped sheet metal and the flooring is wood. There is also a mezzanine office floor at the shore end of first floor to piers 12 and 13. Windows in the office sections are thin glass in wooden frames.

All piers have steel tresslework extending above roofs for attaching tackle, etc., except piers 12 and 13. These two piers have two railroad tracks on the outside of the pier structure on each side extending the full length of the piers. Each floor of each pier is equipped with standpipe lines, trunk line is six inches in diameter and branch lines are three inches in diameter, with hose outlets well distributed, no hose attached at present; Siamese connections each at shore and river ends; standpipes are well covered with hair felt, about 1½-inch in thickness, canvas wrapped. There are five metal curtain boards, spaced about equal distances, across the full width of piers at the roof trusses; average depth of curtains being about 3½ ft.; these curtain boards are omitted on the first floor of the double-decked piers. The superstructures of piers 17 and 18 are not yet erected. Lighting will be electric. No heating apparatus installed, other than temporary coal stoves and open salamanders.

The two outstanding prominent undesirable features in this most important development are the utter lack of protection to the steel members and the vast unbroken areas.

It is contemplated that in the future there will be storage warehouses erected in the area in front of the piers. Work in connection with the filling in of this area is progressing rapidly.

PROBABLE LIFE OF STRUCTURES

In considering requirements for pier and wharf construction, careful consideration must be given to some very important elements, such as the probable life of the pier or wharf, which is dependent on the permanence of traffic, improved method and machinery for handling freight, improved methods of construction that will overcome undesirable features in otherwise preferred locations and increased draft and length of vessels. Ordinarily, the life of a pier is estimated at from twenty-five to forty years. Bottoms are an important factor in the character of construction that can be erected. Soft and deep bottoms limit the size and number of piles and make it impossible to erect the heavier fire resistive structure, while on the other hand, the hard bottoms make it favorable to support the heavier structure. Worms and marine animals attack wooden piling and careful consideration must be given to replacement. Flexibility and elasticity are qualities to be considered and it is important not to obstruct the flow of water and ice. The dimensions of piers and

wharves as to width and length are dependent on the nature and size of vessels that must be accommodated and their area must be sufficient to permit the econmical collection, distribution, inspection and sorting of freight and to accommodate the passenger traffic. These large areas are dangerous unless divided by substantial fire stops. These fire stops should be placed at intervals not exceeding 200 ft., which will materially reduce the danger of a serious fire. This danger can further be mitigated by the installation of automatic sprinklers. Where conditions are favorable for the erection of a fire-resistive structure, this should be done. Such a structure should be subdivided at intervals of 200 ft. by a fire wall, at least twelve inches in thickness, extending from the low water mark to three feet above the roof, and all openings protected by fire doors, one on each side of the fire wall opening. In non-fire resistive piers and wharves, similar walls constructed of six-inch reinforced concrete or its equivalent should be erected and the communicating openings protected by fire doors. Where the construction of the pier or wharf will not support the heavier wall construction, fire stops made of two thicknesses of two inch seasoned tongued and grooved boards with one-quarter-inch asbestos boards between, may be used. Preferably fireproofed wood should be used. When ordinary lumber is used, it should be thoroughly coated with fireproof paint at least once a year. Solid splined planking four inches in thickness, similar to that used in the construction of floors in mill constructed buildings, is an equally effective fire stop.

ROOFING MATERIAL

The roofs of piers should be wholly non-combustible other than the light wooden purlins, and in each fire section there should be at least one skylight glazed with thin glass and protected by wire screening above. In case of fire, the thin glass lights afford an outlet for the smoke and has the advantage of tending to draw the smoke and fire to a single point rather than diffuse it. Such skylights, however, should never extend over or across the fire stops. Roof trusses of steel should be protected by wire lath and cement plaster, one inch in thickness. Stairs, elevators or other floor openings should be enclosed in fire-resistive enclosures carried through the roof and glazed with thin glass skylight, screened, and the door openings protected by fire doors. Office, rest, auction, rigging room, carpenter shop or other rooms of hazardous occupancy should be enclosed in fire-resistive enclosures and cut off by fire doors.

Steam should be used for heating and the boiler room enclosed in fire-resistive materials, cut off by fire doors. Particular care should be given to the mounting of the boilers to secure ventilation in the foundations by means of hollow tile or a series of piping. Experience has shown that solid masonry foundations

underneath boilers, especially on piers, is not good practice. Fires have occurred in the pier decks where heat has radiated through from 12 to 14 inches of concrete. This is probably due in a large measure to the movement or swaying in the pier structure opening up small cracks or fissures in the concrete. Another very important feature is the safeguarding of the smoke stack. Usually these are of metal and where passing through the roof should be ventilated by metal casings to secure a free and continuous passage of air. The stack should be insulated throughout by fire-resistive covering and this covering protected against injury from the storage of the cargo. Ashes from boilers should be thoroughly wet down and placed in metal ash cans or in a bin of fire-resistive materials pending frequent removal from the premises. Oil and lamp rooms should be entirely of fire-resistive materials and cut off by fire doors. Metal lockers only should be used for clothing, no wooden lockers under any circumstances should be permitted. Lockers should be inspected regularly to see that they are kept clean. A separate room of fire resistive construction is desirable in which to locate the lockers.

The exposure hazard of piers and wharves arise from the presence of vessels in the slips or from burning floating materials. There has also arisen in recent years a serious hazard due to presence of floating oil discharged from vessels burning fuel oil. This oil has in a great many instances thoroughly coated the exposed piling and under deck of piers and add seriously to the possibility of a conflagration. These hazards can be minimized by fire resistive construction, the installation of roof hydrant outlets, prohibiting unnecessary fires on lighters, barges or floats that are docking and which should be in continual charge of responsible persons and the prohibition of smoking. A wise precaution is to have trap doors and ladders leading down underneath piers, so fire can be fought from the under side; also dwarf doors cut in the cargo doors to afford ready access to the piers. These cargo doors are very large and in many instances form almost the entire sides of the pier. The necessity for the large size, particularly the height, is to afford clearence for cargo from the ship deck, which varies considerably from the rise and fall of the tide, and the use of derricks for handling the cargo. These doors are none too substantially constructed or secured to resist fire. Their primary function seeming to be the ease with which they may be handled. Ladders with which to reach the roof should be available and where exposure to other property is serious, outside sprinklers should be installed. Employees should be drilled to be on the alert for inflammables and explosives and arrange for their proper handling, keeping separate from other cargo, and commodities of this nature should not be permitted to remain overnight, except in emergency and then under safe protection.

Automatic Sprinklers: A complete approved system of automatic sprinklers should be installed.

Open Sprinklers: A complete system of open sprinklers should be installed where piers of wharves are subject to severe exposure.

Standpipe System: An independent standpipe system should be installed and used for fire protection purposes only. Ships should be supplied with water from a separate supply line. For piers 500 ft. or less in length the standpipe lines should be not less than 6 inches in diameter; for piers over 500 ft. in length an 8 inch line should be used. Where piers are over 60 ft. in width, a loop system should be used. Hose outlets should be installed at intervals of not more than 100 ft. Provision for first aid streams, as well as powerful streams for use by organized fire brigades or public fire department, should be made. All piping should be protected against freezing by enclosing in at least 2 inches of mineral wool or other suitable lagging, and further protected by circulating hot water or by the installation of a steam or hot water line enclosed with the supply line. Standpipe system should be supplied from one of the following sources (2) Municipal water system, capable of supplying not less than four effective water streams; (b) Standard Underwriters fire pump of at least 1,000 gals. capacity; when pump is drafted to salt water, the system should be charged at all times with fresh water; (c) Gravity tank of not less than 60,000 gals. capacity; bottom of tank elevated 50 ft. above the roof; tank supply to be used for standpipe purposes only.

Roof Hydrants: One standard two-way roof hydrant should be installed on the roof, spaced not over 200 ft. apart. These should be provided with standard hose. Roof hydrants should be supplied through not less than a 4-inch gated connection from the standpipe lines.

Standpipe Heating System: Any independent or separate heating system for heating standpipe lines should have the boiler located in a detached building. When this is not possible, the boiler should be located near the shore end and in a fire-resistive enclosure.

Fire Department Connection: One or more Siamese fire department connections, properly checked and drained, should be provided at each shore and water ends.

Monitor Nozzles: Should be installed on the roof at intervals not exceeding 200 ft. and located midway between the roof hydrants.

Casks, Pails and Bucket Tanks: On each side of pier there *should be placed* at intervals of 100 ft., one 50 gal. cask of water

and three fire pails. Casks to be painted red and marked "For Fire Only." Casks should be provided with substantial covers. Where casks are liable to injury from tucking they should be mounted on platform and protected by substantial guards.

Pump Tanks: Approved five-gallon pump tanks may be installed to replace one-half of the cask and pail equipment; the pump tanks to be distributed so as to alternate with the cask and pail equipment.

Chemical Extinguishers—Approved non-freezing chemical fire extinguishers may be installed to replace one-half of the cask and pail equipment; the chemical extinguishers to be distributed so as to alternate with the cask and pail equipment.

Chemical Engines: In addition to the first aid hand devices, approved chemical engines may be installed on the basis of one engine for each 20,000 sq. ft. of floor area. Unless the engines are of the non-freezing type, each engine should be housed in an enclosure suitably heated to prevent freezing.

Watch Service: Approved watch service should be provided for each pier with watchman on duty at all times. Watchman should be carefully and fully instructed with regard to the summoning of aid, maintenance and use of all fire appliances, inspection of hazards and closing of fire doors.

Fire Alarm Signal System: An approved manual fire alarm signal system should be installed and arranged to sound a local alarm and summon the private fire brigade and public fire department.

Fire Brigade: A private fire brigade should be organized among the employees of the pier. The fire brigade should include a special detail to close all fire doors at time of fire and drills.

General Care: Some one man should be responsible for all fire prevention and protection matters, to whom shall report the heads of the fire brigade, and who shall at all times impress upon the employees the necessity of fire prevention and what to do in the event of fire.

LOADED TIMBER COLUMNS

Results of Series of Experiments Made By Underwriters' Laboratories, Chicago

By Theodore F. Laist, Chicago, to Building Officials' Conference

The fire endurance classification of a nominally 12-inch by 12-inch select structural long leaf Southern pine or Douglas fir column of ordinary length, may be more than doubled if the ends are adequately protected against fire. It appeared from these tests that instead of a thirty-five minute endurance rating, a one and one-quarter hour rating may safely be given, providing the steel caps as ordinarily used are insulated or a concrete cap is used, thus preventing the crushing and brooming of the wood fibres under the cap and causing failure long before the sectional area of the column is otherwise reduced to a point of failure. It has also been shown that such adequate fire protection for the ends of timber columns in mill construction buildings may be obtained by reinforced concrete post caps such as were used in these laboratory tests. While such caps have been successfully devised for experimental purposes, so far they have not been commercially producd, nor have such tests been made upon caps supporting girder loads.

While in this series of tests by Underwriters' Laboratories no experimental work was done with steel or cast-iron caps, it is apparent that consideration of the results obtained would suggest that adequate insulation for the ends of timber columns may be obtained from the installation of fireproof materials on the exposed faces of standard steel or cast-iron post caps.

UNSUCCESSFUL METHODS

Other methods of insulating metal caps have so far not been succesful for it has been determined, by actual test, that interposing, insulating materials of various kinds and thickness between the metal post caps and the ends of the timber columns does not prevent failure of the columns by local end crashing, when loaded and exposed to fire.

These are the important conclusions which may be drawn from the series of tests carried on at the request of the National Manufacturers' Association. That the knowledge thus gained will have in time a far-reaching effect on mill construction is obvious. The way has been pointed out for

further investigation in the design of the most commercially practical cap. The concrete cap has solved the problem and there is the alternative of using a protected steel cap. The mechanical difficulties of so insulating the standard metal cap as to achieve the required result should involve no great difficulty. While the concrete caps used in the experimental work did not sustain girder loads, sufficient is known in regard to the design of structural members of concrete and the behavior of reinforced concrete under fire and similar conditions to justify the assertion that no difficulty need be anticipated in this direction. The tests also verified the greater superiority in fire resistance of timber construction to unprotected steel or cast-iron framing.

It may be interesting to follow the history of the development of this work and review briefly the tests which lead up to these investigations.

PREVIOUS TESTS OF COLUMNS

The circumstances which led to the tests and which eventually became the basis for the above stated conclusions were brought about by observations made during a series of 106 fire tests of loaded columns of various materials, which were carried on during 1917 and 1918 at Underwriters' Laboratories and conducted jointly by the Associated Factory Fire Insurance Companies, The National Board of Fire Underwriters and the Bureau of Standards. Among this series were included six tests of timber columns, four of the columns being unprotected, the others being protected by various means, the latter are of no special interest and have no direct connection with the subject of this report. Four of the columns tested at the time were made of long leaf pine and two of Douglas fir. The post caps used were of steel of standard design. The time of failure of the unprotected timber columns varied from thirty-five to fifty minutes. The failures were localized in each case at the bearings with the metal caps, and occurred at the end of the column in contact with the steel or cast-iron caps, through crushing and brooming of the fibres followed by slipping or failure of the cap. Because of such premature failure the full resistance of the columns, under conditions generally assumed in the column formulas, was not obtained. During the test of the unprotected columns, the deformation at the bearing increased rapidly after the first twenty minutes, and at the time of failure was in excess of three inches.

POST CAPS

The post cap was one especially devised for this series of tests, and to which reference has been made previously in this paper. The reinforcement was made of 1/4-inch Havemeyer

rods, bent by hand, and welded at all surfaces of contact. The concrete was made of 3 parts (by volume) of cement, 2 parts of Fox River sand and 4 parts of crushed limestone, which passed a ½-inch mesh. The caps were removed from the forms after about seven days and were tested after they were from twenty-four days to five months and twenty days old. The weights of the caps varied from 316 to 335 pounds. It is not possible, within the scope of this paper, to give a detailed description of each sample and the observations made during individual tests, but the following general statements may be accepted as applying with sufficient accuracy to all:

The character of the fire at the beginning of all tests was luminous and fairly well distributed, in every case the flames being in contact with all parts of the sample.

APPEARANCE OF SAMPLE DURING TEST

The wood members began to char immediately and the contraction of the charred material produced a checkered appearance on all exposed surfaces. In each case vertical checks appeared in the column and during several of the tests the column split vertically along the whole length of the column. The concrete cap was bright red at the conclusion of the test in each case. The edges were in part superficially calcined, the flanges slightly spalled. Hair cracks developed throughout the cap. In only one of the tests, C-4, the concrete cap showed cracking which, however, was not a primary failure of the cap, but was due to the lateral thrust developed by the column at the moment of failure, neither did this condition of the cap produce or contribute to the failure of the column.

TEMPERATURE WITHIN THE SAMPLES

The line temperature curves showed the average furnace temperature to have been approximatly from 1800-1850 degrees at the time of failure. The average temperature in the concrete cap was in the neighborhood of 300 degrees.

PYROXYLIN PLASTIC STOCKS

Conditions Under Which This Material Becomes Dangerous; Methods of Fire Extinguishment

By H. L. Miner, du Pont de Nemours & Co.

Extended use of pyroxylin plastics and their presence among other mercantile stocks in much larger quantity than is often revealed in daily and inspection reports makes an understanding of this substance's peculiarities more than ever necessary to the fire underwriter. What follows is taken from a report on pyroxylin plastic fire tests by Mr. Miner, a member of the National Fire Prevention Association committee on hazardous chemicals and explosives:

There has been considerable speculation regarding the derivation of the word "pyroxylin." In the European Dictionary of Arts and Manufacturers, 1853, the word "Pyroxyline" is the name applied to a substance detected in pyroxylic spirit, the old name for wood alcohol. It seems evident from this that the derivation commonly applied to pyroxylin as coming from the Greek words for "fire" and "wood" apply rather to this old term for wood alcohol, since wood alcohol is the spirit derived from wood by fire. The term "pyroxyline" then seems to have been applied to the particular nitration of cellulose now known as "pyroxylin" because of the fact that it was soluble in wood alcohol and thus distinguished from nitro-celluloses of higher nitration.

Pyroxylin comprises the lower nitrated products resulting from the action of nitric and sulphuric acid on vegetable fibre, cellulose. As already brought out, it is distinguished from the higher nitrated products by its solubility in wood alcohol.

Nitrocellulose is a generic term covering all classes of nitrocellulose. While the different classes of nitrocellulose are similar in certain general characteristics, they are very dissimilar in others, and the chief means of distinguishing one class from another is the nitrogen content of the material, which ranges from 10.5 to 13.5 per cent.

Nitrocelluloses may be classified roughly according to their nitrogen content into three classes:

a. High grade guncotton contains from 13.3 to 13.7 per cent. of nitrogen, is soluble in acetone, but insoluble in ether-alcohol.

b. Pyro-nitrocellulose with a standard nitrogen content of 12.6 per cent., the base of most smokeless powders, is soluble in ether-alcohol, but not soluble in methyl alcohol.

c. Pyroxylin includes a class containing from 10.5 to 12 per cent. of nitrogen, and is soluble in wood alcohol as well as certain mixtures of solvents which will not dissolve the higher nitrations. Varnish or collodion cottons usually contain 11.5 to 12 per cent. of nitrogen. These are used for artificial leather, lacquers, enamels, photographic film and similar purposes. For pyroxylin plastics, pyroxylins are used which contain 10.5 to 11.5 per cent. nitrogen.

The inflammability of the cellulose nitrates is dependent on the percentage of nitrogen; consequently the pyroxylins as a class are non-explosive and are much less dangerous than others which have higher nitration contents.

Pyroxylin plastic compounds may be defined as solid solutions or mixtures of pyroxylin or similar material with another substance, usually camphor. They are commonly known as "celluloid." This term, however, is a trade name applying only to the product of one manufacturer. Pyroxylin plastic is the proper general term to include all materials commonly known as celluloid, such as "celluloid," "pyralin," "fiberloid," "xylonite," "viscoloid," "Parisian ivory," "French ivory," "ivortone," etc.

It is not considered necessary to call your attention to the suitability of pyroxylin plastic to a wide variety of purposes, to the place that it holds and the need that it fills in our industry, or to the fact that the demands placed upon this material are continually increasing. It is one of the strongest artificial materials, possessing a tensile strength of from 6,000 to 12,000 lbs. per square inch. It takes a beautiful finish and has great plasticity, softening upon heating and regaining its strength and appearance upon cooling, and can be moulded in dies to any desired form, cut, sawed, turned in a lathe, etc. For many of its uses no material known today would make a satisfactory substitute.

Pyroxylin plastics and the gases resulting from decomposition have a high ignition point. The hazard, however, lies in the relatively low temperature needed to start decomposition. The statement is often made that pyroxylin plastic will decompose at or slightly above the boiling point of water. This is not true except possibly in the instance of some of the very unstable foreign plastics which are now being imported. This, at the present time, refers principally to plastic imported from Japan. As now prepared, pyroxylin plastic is very stable against the action of heat, although, of course, readily ignited by flame.

When heated slightly above the boiling point of water, 212 degrees F., pyroxylin plastic gradually loses weight due to

volatilization of camphor, but several days' heating is necessary to produce a noticeable effect.

At 275 degrees F., or the temperature of steam at 30 lbs. pressure, decomposition proceeds very gradually, although samples of poor stability begin to disintegrate after about one-half hour's exposure. At 300 degrees F., the temperature of high pressure steam of 54 lbs., a badly stabilized material will decompose within a few minutes, while material of a standard quality will not be decomposed inside of half an hour.

At temperatures ranging from 320 degrees F. to 390 degrees or 400 degrees F., pyroxylin plastic will decompose rapidly, giving off brown fumes and leaving a friable residue. At normal atmospheric temperature, pyroxylin plastic is stable for an indefinite time, samples of material over forty years old being in good condition and apparently unchanged.

U. S. Government tests show that the temperature of ignition of pyroxylin plastic or its gases approximates 800 degrees F., but for practical purposes the tendency of this material to decompose at temperatures below its ignition point should be the measure of hazard.

The gases consist of nitrogen oxides, carbon monoxide and nitrogen; methane and hydrogen are sometimes present. Carbon monoxide, methane and hydrogen are inflammable and under certain conditions will form explosive mixtures with the air, even though the original pyroxylin plastic is not explosive. It should be kept in mind that the decomposition is self-sustaining; in other words, when decomposition once starts it is likely to continue unless the heat developed is absorbed or conducted or radiated away. If the material is insulated the temperature of decomposition may even become sufficiently high to ignite the inflammable vapors which are being developed.

To extinguish fires in pyroxylin plastic two things are necessary: First, the flame is extinguished by the exclusion of oxygen; second, the decomposition is checked by the absorption of heat which reduces the temperature of the material below the decomposing point. Water, therefore, is one of the most effective, if not the most effective, extinguishing agent available, and in the tests it will be noted that fires in pyroxylin plastic are most susceptible to control and extinguishment when the water can reach the burning or decomposing material. Extinguishers or devices depending upon the blanketing or smothering effect of gases or exclusion of air or oxygen are not effective.

A very important point to be appreciated in fires involving *large amounts of* pyroxylin plastic is the possible presence

of nitrous fumes. Similar fumes may be developed in fires involving nitric acid, nitrate of soda, saltpetre or other nitrogen-containing materials. Water will absorb a considerable percentage of nitrous fumes, which consist chiefly of NO_2 and NO. The water spray from automatic sprinklers is as a result very effective in reducing the possibility of danger from this undesirable feature. While only a small percentage of the other undesirable gases, namely, hydrogen, carbon monoxide or methane, are absorbed by the water, the spray cools them below the ignition point and also saturates them with moisture. They, therefore, will not take fire spontaneously when they issue from vault or room and are more difficult to ignite subsequently on account of their water vapor content

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PYROXYLIN PLASTICS IGNITION TEMPERATURES

Fire Hazards of This Material When Subjected to Heat From Steam Pipes—Packing for Shipment

(*Report of Bureau of Explosives, New York*)

Samples of pyroxylin plastic articles were received from the manufacturer. Also similar articles which had been damaged in a fire in an express car on New York Central Lines near Rochester, N. Y.

The samples were as follows:

No. 13801. Mirror. Frame made of white pyroxylin plastic. Condition perfect.

No. 13802. Hair Brush. Made of white pyroxylin plastic. Condition—perfect.

No. 13803. Combs. Made of pale blue pyroxylin plastic. Condition—perfect.

No. 13804. Side Combs. Made of tortoise shell pyroxylin plastic. Condition—perfect.

No. 13805. Mirror. Frame made of white pyroxylin plastic. Partly burned.

No. 13806. Hair Brush. Made of white pyroxylin plastic. Partly burned.

The relative stability of these samples was estimated by determining their temperatures of ignition. This test was made in the following manner: 0.2 gram of the finely divided pyroxylin plastic was placed in the bottom of a test tube ⅝ inch in diameter and 5 inches long. This tube was lightly closed with a cork stopper, and was then placed vertically so that the lower half was immersed in an oil bath at an initial temperature of 100° C. The temperature of the bath was raised at the rate of 5° C per minute, the oil being meanwhile kept in constant circulation. The temperature at which the contents of the test tubes decomposed violently or ignited was observed as follows:

No. 13801	175-176° C.
No. 13802	176-176° C.
No. 13803	168-169° C.
No. 13804	168-170° C.
No. 13805	168-171° C.
No. 13806	177-178° C.

The temperatures of ignition of these samples show that they *were of good stability* and possessing no more fire hazard than *is inherent to pyroxylin* plastics.

EFFECTS OF HEATING

Tests made at the Arlington works in 1918 showed that good pyroxylin plastic packed in double-faced corrugated strawboard containers and kept at a distance of two inches from a steam radiator with 70 pounds steam pressure, showed but slight decomposition in 72 hours, constant heating. These tests seemed to show that pyroxylin plastic packed in double-faced corrugated strawboard could not be ignited or seriously decomposed by the steam-heating system of an express car provided that the radiators in these cars were perfected by metal or wooden screens so that all packages are held at least 2 inches from the steam pipes.

If there are no screens protecting the steam pipes or if these screens are in such defective condition that packages may come in contact with the pipes the contents of these packages will get much hotter than if there was two inches of air space between the packages and the pipes. Under such conditions it is considered probable that pyroxylin plastics inside such packages will be ignited by the heat. The steam pressure in the pipes at the time of the recent fire was 75 pounds per square inch. This pressure will give a temperature of 160° C. in the pipes. This temperature, while below the temperatures of ignition given above, will certainly cause ignition of pyroxylin plastics if continued for a number of hours.

BUREAU REPORTS AND THEIR USES

Such Information on Special and Other Fire Hazards Seldom Treated as Fundamental, But Rather as News

*By J. G. Hubbell, Manager National Inspection Co., Chicago**

The relationship of inspection reports to underwriting and the work of examiners depends on the importance of the risk and the quality of the report. You gentlemen are familiar with reports; perhaps you are not so familiar with the duties of an examiner. Your problem is to adjust the report to the needs of the examiner. I am sure there is a misunderstanding on the part of many reporting officers as to just what use is made of all this information so carefully collected and set forth. The very explicitness with which unimportant matters are recounted is evidence of this.

It is not possible to go into analysis of the different gradations of authority possessed by examiners in different offices. In some offices the examiner is a well paid official practically supreme in his own department. In other offices he is little more than a clerk, the underwriting authority being held by the managerial officers of the company. But, in all offices the great bulk of examining is done without reports. This may seem strange to you, gentlemen, but it is a fact that reports are looked for only when the peculiar hazard of the property or its size make necessary the consideration of the business from a standpoint broader than that of ordinary office routine. The examiners know a good deal about the general characteristics of the risks in their respective fields and about the fire protection in the cities and towns in which they are doing business. This comes through familiarity and is not worked out each time for individual risks.

ELEMENTS OF UNDERWRITING

Practically every risk that comes up for consideration in a general office comes as a daily report of a policy written or as an inquiry for an authorization. The ordinary implements of underwriting are the Sanborn map, the rate book, the daily report and the commercial report secured through Dun or Bradstreet. The great bulk of premiums handled in a general office goes through with no reference to any other sources of information than these. The guide is the company line sheet, the examiner's duty being to make certain that the risk is properly

*Address to the Fire Underwriters Uniformity Association.

classified as to occupancy, as to whether it is frame or brick or fireproof, protected or unprotected, and that the concern insured is responsible financially and that the risk, as indicated from its appearance on the map, the local agent's comment, the evidence of the commercial report and acceptability of classification, policy form and rate, is one which the company desires. These being all acceptable, he passes the business.

METHOD OF REASONING

His method in ordinary situations is largely one of being assured that the risk is not unacceptable rather than one of finding out how acceptable it is. The reason is that in the great bulk of cases the amount offered is well within the limits of what the company is prepared to write. He knows enough about it to be satisfied. He knows the trustworthiness of the agent he is dealing with. His reliance is on the responsibility of his agent and of the assured as indicated by the commercial report, so long as there is nothing in the activity of that assured which would involve dangers in regard to which he would not be prepared to accept the assured's judgment. The hazard of physical assembly is presumed to be taken care of by the rate named in the tariff book. The examiner is wholly disinclined to initiate inquiry unless inquiry is manifestly necessary, as every inquiry takes time and is likely to cause friction between the company and the agent or the agent and the assured.

The whole business of underwriting is built on this foundation, and dwelling houses and mercantile business, routine sorts of special hazard business and renewals go through without more than occasional inquiry here and there to check up some point which makes the examiner feel that further information would be desirable. The necessity of handling business at a minimum expense makes any other method impracticable.

IMPROVED RISKS

The area in which reports of bureau character are desirable and serviceable to an underwriting office is pretty strictly limited to so-called improved risks, heavy mercantile properties and important manufacturing special hazards generally. Important non-manufacturing special hazards of recognized hazardous type also come in this group. In underwriting these larger and more complex risks, questions of desirability are not so readily nor so safely arrived at by assumption, and the examiner is obliged frequently to examine data on file to find out just what sort of a risk he is taking.

Now in this process of closer consideration, the report from any individual bureau, no matter how centralized the reporting *activities in the* district may be, is probably only one of several

sources of information for data of this character. He will value the various reports before him in proportion to their accuracy and the convenience with which he can secure the desired information from them. If, to get an answer to his question he must construct a mental picture of the property from a lot of statistical or semi-statistical elements, the report is not serviceable, and he in time comes to ignore it and look elsewhere for his data.

HOW REPORTS ARE USED

Reports are used two ways. The fundamental use is the one which the bureau reporting office probably has in mind as the only use but is peculiarly the use to which the report is least frequently applied. In fact, out of the great body of reports received, it is only occasionally used in the fundamental way; that is, for the deriving of a complete first hand understanding of the occupancy, assembly and general characteristics of the property reported upon. The other use is in theory secondary, in practice primary, and, as regards the great bulk of reports, the only use to which the report is put, that is, as news.

ASSEMBLING INFORMATION

Considering the case of the fundamental use, an examiner assembles all the information from all sources concerning the risk under consideration and reviews the information to get the general import of the views about the property, and from all these different reports he comes out with his conclusion as to the rank and merit of the risk as compared with other risks of its class. He adjusts his line and specifies what reinsurance is to be provided if the line is large. This adjustment is duly recorded as a guide for future offerings on that property. Having so adjusted his underwriting he sends the reports to file, and never reviews that case again until the advent of information from some quarter indicating that the risk is materially changed makes it advisable, when the process will be repeated. But it may be five years in the history of many risks before any such occasion arises.

When the examiner is using the report in this way it is important to have it so stated that he can get the substance of it quickly, and in this particular much remains to be accomplished.

FACTORS IN ACCEPTABILITY

The determining factors in the acceptability of a line of insurance may all be reduced to one generalization, which is the quality of the offering. Good underwriting admits of acceptance of *points of dominant* importance only in building up such generalizations. *Minor* variations cannot be considered. It is the *quality of the assured* and of the occupancy, the quality of the

construction, the quality of the arrangement and the quality of the protection which determine the desirability.

ESSENTIAL INFORMATION OMITTED

The difficulty confronting an examiner in his use of the ordinary bureau report is that, for fear of committing himself, the reporter avoids the use of those very expressions which would impart to the reader at once an understanding of the inspector's estimate of the quality of these various characteristics. He seeks to overcome it by a detailed listing of all the statistical information about all portions of the property, presuming apparently that with this statistical information, the man at the underwriting end of the line should at once be able to judge the quality of the offering. But it is not so.

TERMS OF QUALITY

If I tell you that water from the springs of Waukesha contain, let us say, 50 grains of sodium chloride per gallon, you are unable, unless you are familiar with the effect of this quantity of salt, to know from my statistical narrative whether the water is flat, refreshing or salt to the taste. But if I tell you in so many words that the water from the springs of Waukesha is refreshing, you have the answer in terms of quality.

Now it must be remembered that, barring the few men who have recently come into the general office from the field and are able to judge such matters, the man at the underwriting desk is not in position to know how many chemical extinguishers per thousand feet of floor area constitute good protection or what value from a fire protection standpoint is represented by the difference between 300 and 350 sprinkler heads in a given floor area. Factors which cannot be brought out in the report bear on the adequacy of the protection afforded.

WHAT UNDERWRITER NEEDS

Fundamentally he assumes that the protection is measured for by the rate paid. He is interested in the protection, not so much for its own value, as he is from the standpoint of its indication as to the quality of the assured and the quality of the risk he is dealing with. Therefore, the answer he wants is not a list of the number of chemical extinguishers or the number of automatic sprinklers per floor. What he wants the report to say is that there is an abundant or a scant supply of chemical extinguishers; that the sprinkler heads are well placed and spaced, and cover all areas, or that they are not so; that the construction is *substantial* or otherwise, etc. It is a physical *impossibility for him to* determine the adequacy or inadequacy without

having also seen the property. The inspector is the man who saw the property. He is presumed to have some intelligent understanding of such matters, and the underwriter looks to the report of that inspector for the inspector's opinion of the risk.

Now the quality of a risk in its class depends on the character of the construction, the condition of repair, the prosperity and stability of the business, the intelligence of arrangement with reference to the processes and hazards involved, the care used in administration and the character of fire protection, both public and private. Having these things before him, the examiner then goes on to determine how much of the risk will probably go in a single fire and from what hazard the fire producing such a loss is most likely to arise, and adjusts his line in recognition of all factors.

BRICK WHOLESALE GROCERIES

Let us take one or two concrete examples. We will assume that we have two substantially equivalent brick wholesale grocery risks, both of average joisted construction, one with floor draftways open and no internal fire protection, the other with floor draftways closed and standard internal fire protection. The rate on the one without draft cut-offs or hand apparatus will be higher, but the commercial listing of the occupant of this risk is an A rating, while that of the assured in the better physical property is a C rating. In ordinary underwriting the examiner will hardly go so deep as to make much distinction beyond that suggested by the difference in commercial rating. The risks appear the same on the map. His classification makes no distinction closer than brick wholesale groceries. His experience is that joisted wholesale risks burn up, either with or without floor drafts closed off. The only difference important to him is in the "C. R.," and that will influence him to be liberal with the A rated concern where he soon finds he has enough of the C rated house. Perhaps if some one emphasized to him the technical inferiority of the A concern's property he would reduce his net retention somewhat, but he would still be very liberal in his gross acceptances. Even with the appearance of manufacturing operations in the A rated concern's premises he probably would still feel inclined to write more liberal gross lines (unless office rules forbade) than on the C rated house. The examiner is willing to ignore the inferior private protection and arrangement of the building the A rated concern occupies in view of its manifest success as a business institution. The fact that they do not close off draftways or install hand apparatus he knows is *not to their credit, but* he suspects the C grade concern of doing *it for rate reduction* and not from desire for safety.

MACHINE SHOP

Take another instance. Machine shops are a characteristic and very familiar class. The shop of former days was one or two stories joisted brick. The shop of today is a high, one-story affair with a good deal of glass in the walls and even in the roof, and a naked steel interior framing. This modernness of arrangement in such an occupancy greatly minimizes the chance of a fire of ordinary sort getting a foothold in the roof and, in a one-story arrangement, unless it does get a foothold in the roof it cannot spread. Actually both the old and new type are subject to a total loss once a fire gets a foothold, assuming the shops to be of reasonably large area. The presence or absence of hand apparatus does not influence the question on ultimate loss probable in either type of shop, but it would tend to indicate the quality of the concern insured. Its bearing on the case is not for its own value at all, but is taken wholly as an indication of the quality of the assured.

QUALITIES THAT GUIDE UNDERWRITER

As between two apparently equivalent assured in otherwise equivalent properties, the one with standard first aid equipment would be regarded as the more progressive and better concern, but any such considerations would be quite outweighed by an inferior commercial rating or evidence of slack administration of premises. In this case, however, the great superiority of the new type of construction so reduced the fire hazard as to put the property over into a superior class and make it ordinarily acceptable for three or four times the unit liability subject to one loss which the old shop would be acceptable for. The old type of shop is to some extent declassed by the appearance of the new type, and is recognized as one of a kind which will in time harbor second class concerns. The first class concerns are rapidly equipping themselves with new type shops or removing into them, and the loss record on the old type shop may be expected to climb steadily in consequence. The informed underwriter, therefore, loads up on the new type shops and wants the reports to reveal this characteristic at once.

I have tried in these instances to show how qualities guide the underwriter in the selection of his business. In general these characteristics cannot be sufficiently brought out by statistical statements. They require the use of defining phrases or words, and your reports will be valuable to the underwriter just as your inspectors are qualified to bring out these aspects of the properties they report upon.

USE OF REPORTS AS NEWS

Now turning to the secondary but really universal use of the *reports; that is,* as news. This aspect of the case seems nearly

to be lost sight of by reporting offices. I have pointed out that the fundamental but nevertheless occasional use of the report is to give the examiner complete data, and have shown that so far as possible the report should convey this information in terms of quality. Now I purpose to show that at some regular and quickly accessible place in each report must be a specific paragraph incorporated with the intention of relieving the examiner from any necessity of reading the report when all he wants is news of the risk. All reports of whatever sort have to be handled from this standpoint most of the time. So far as the great bulk of cases is concerned he has already adjusted his underwriting and, provided no change has occurred of importance sufficient to warrant modifying what he has done, he will use the report only to be assured that such is the case.

The reports come to him in packages of several hundred every week, and sometimes two or three times a week. Each report becomes a part of the office file. If anything in the way of change such as should effect the underwriting has taken place in the risk, the underwriter is held responsible for knowledge of that change, and is expected to make the necessary readjustment of his line. It is exactly as important for him to know that there has been no change of moment in a risk as it is to know, if it has changed, what change has taken place. The report must show distinctly, conveniently and concisely the exact situation. It seems to be thought that the examiner is going to go through in a summary way the outlines of the information in the report submitted by the bureau. That is wholly erroneous. The information is not read. The examiner has not time to read it. The only time he does read it is in the case of those instances here and there where the underwriting of a line is being initiated or overhauled. In all other cases, constituting as they do the great bulk of business he is handling, he is wholly uninterested in details of information and is interested exclusively in the answer to the single question as to changes, and if any, in what important particular.

SOME DETAILS A NUISANCE

Unimportant changes are regarded as no changes for underwriting purposes. Consequently the inspector or the reporting office which is so accurate as to be sure to note every change in order that its skirts may be clear, is little short of a nuisance. Detail matters relating to the removal of a sprinkler head here and the restoration of one there, minor additions and reconstruction, etc., are of no essential importance, and the incorporation *of such* items under the heading "Changes Since Last Report" *fogs the situation* and consumes valuable time. The examiner *must get his news* out of two or three hundred reports in an *hour's time or less,* and his function in that connection consists

primarily in authorizing the passing of the report to file by placing his initial upon it. He cannot do this unless he is satisfied that the reports carry no information of consequence to the underwriting department, and there is no information of consequence to the underwriting department unless there has been a real change in the risk, as to construction, or activity, or occupancy, or arrangement of hazards, or grade of administration, or protection, or of ownership.

In conclusion I have little to offer. My position on your committee is more or less anomalous for the reason that I steadily have found myself unable to adopt much of the Uniform Report beyond the suggested order of headings. My theory of presentation of data differs wholly from that which underlies the reports issued by most offices, and the carrying out of that theory requires a different office organization. Whether it is better or worse than other methods is a matter of opinion.

I feel that if you will study to eliminate or reduce statistical data and permit the use of interpretive and descriptive narrative comment instead of trying to inject everything under headings, you will accomplish a vast deal in the way of increased serviceability of your already excellent reports.

METER INSTALLATION HAZARDS

Average Electrical Equipment Far From Ideal—Suggestions for Reduction of Hazards—Safety Cabinets—Grounding

By J. C. Langdell, Electrical Inspector

During the early part of 1919 it was brought to the writer's attention that difficulties were being experienced relative to making proper tests and adjustments on consumers' meters. Upon further investigation it was found that owing to no uniform system of co-operation between the electrical contractor and the utility, conditions at our various meter installations showed tremendous possibilities for improvement. I do not believe that our conditions were any worse than in any other locality where no interest was taken regarding the service. These conditions were immediately called to the attention of the various municipal inspection agencies and electrical contractors regarding the possibility of improvement. Our brief recommendations consisted of:

1. Installation of conduit entrance terminating in safety cabinet.
2. The use of the safety cabinet completely enclosing all meter wires in metal.
3. The proper grounding of secondaries.

With reference to the first item, I think it is generally agreed that in all cases the entrance service wires should be installed in metal.

METER SAFETY CABINETS

The application of an enclosed switch at the entrance service should not be confused with the industrial application, and in most cases, cannot be applied for interchangeable use. It has been recently brought to our attention that in certain localities an enclosed switch is installed at the service entrance and an open switch at the branches; such construction is valueless and only complicates constructive safety movements. If an enclosed switch is an addition to safety at the entrance, it equally applies to all of the circuits. The problem of the central station are many in working out an economical and feasible basis for good meter installations. First, let us take the plan *requiring* such efforts on the part of the utility, that is, that *they purchase a* device direct from the manufacturer, install [illegible] *arrange to have* the contractor do this work, all of which

costs a tremendous amount of money and there is a question in my mind whether the utility receives in return an amount in comparison to the cost. It has been our purpose to sell these safety recommendations to various governmental bodies, electrical contractors and consumers. We have earnestly sought their co-operation, explaining in detail the decrease of hazards to life and property by the use of lantern slides, and from the viewpoint that we were in advocating this type of construction adding safe-guards to our various consumers. In all the districts where safety cabinets are being used it has the universal approval of the electrical inspectors and majority of electrical contractors. I want to emphasize at this time that you cannot expect to obtain 100 per cent installations without the close co-operation of the people involved in the transaction, namely; the city electrical inspector, electrical contractor and the utility.

AMONG THE MANUFACTURERS

The present condition of the manufacturer of these safety cabinets is such that makes the situation comparatively easy for the various parties to co-operate for the improvement of installation. Fortunately, five manufacturers at the present time manufacture a standard safety cabinet which are practically interchangeable; all taking one standard meter trim and can be grouped together in the case of an apartment installation. This situation practically solves the difficulties that have been experienced in the past, especially when the device is being handled thru the contractor dealer; and it does permit the standardization of end walls and connections, which has been a problem from the standpoint of the central station. I doubt if any of you gentlemen present question the desirability and necessity for standardization and this is one of the few devices in the electric business that is interchangeable; even a simple accessory like the ordinary attachment plug cannot be attached from your vacuum cleaner to the average heating appliance. The average central station has on its lines six or seven different types of meters, two and three wire, ranging from five to one hundred amps. It is at once apparent how impractical it would be to attempt to stock and furnish more than one type of end wall, and suppose that we consider it would be practical, how would we know what end wall to send out with the meter until we made the actual installation. The question naturally arises, "Why not have the electrical contractor furnish the end wall?", all of which is feasible until the meter burns out and we have to change the type. Where will we obtain the end wall and should we expect the electrical contractor to carry a complete set of end walls for the particular make of device he is handling? It has been my experience

that several companies have endeavored to handle it in this manner but with not much success.

FOUND IN ORDINARY PRACTICE

There is no question but the use of the enclosed switch is so far superior to the open type, but, in our judgment, it does not represent the safest installation. The average practice is as follows:

The entrance conduit is installed and connected direct to an enclosed switch, all of which is good practice; open wires are then connected to the enclosed switch and run to the meter; thence to the branch cutouts, which in the majority of installations are not even closed.

Let us analyze this installation.

1. The contractor installs service wires in conduit and run open wires to the meter. Why not enclose the meter wires?
2. It is the practice in a good many cities to install any enclosed switch that is approved by the fire underwriters, irrespective whether it has sufficient clearance for the utility to economically and safely test the meter.
3. With reference to the average installation, the city electrical inspector and a great many central stations are not interested as to whether the switch is sealed and permit the consumer to destroy all of the protection that the city electrical department is endeavoring to give him. From the standpoint of the utility, it permits the theft of electric current which I believe exists in varying quantity in every town and city in the United States. Now, why should the city electrical department advocate means be provided to prevent current theft? The reason is, the consumer in stealing current steals from every honest consumer as well as the central station, and in sealing these cabinets you are protecting the revenues of all its consumers. There is just as much reason for allowing the entrance service to be exposed as there is in leaving your front door open and requiring the central station to furnish unmetered current, trusting entirely upon the honesty of its consumers.
4. A great deal of propaganda has been advanced explaining the danger of the open knife switch, all of which is of tremendous improvement along safety lines, but if a hazard exists at the switch, why does not a similar condition exist in connection with the branch cutouts? It is our belief that in order to make safe installations you must completely enclose in porcelain or steel the branch cutouts.

MAIN LINE CUTOUTS

It has been our experience that improper use of material in *the main line cutouts* has resulted in fires and it is the writer's *belief that it is* one or the greatest electrical hazards that

exists today. Our purpose in recommending the sealing of these entrances fuses, we believe, results in better protection to our consumers and to ourselves.

The Code requires fuses to be installed at the entrance of the building and I do not believe there is an inspector present today who cannot go back home and obtain a collection from these so-called safety valves, ranging from copper pennies to solder, without a very diligent search. I think you will all agree that these conditions exist. We know they do on our properties, and believe they always will until such time as we are completely protected by the use of enclosed safety cabinets. The present practice seems to be that the electrical inspector or some one in position to know the danger, tells Mr. Consumer or Mr. Contractor, "Please do not plug the fuses, as it is dangerous." Is it not a safer and saner method to prevent the tampering of this safety valve than to permit the hazard which is considered in a great many localities more or less of a joke.

WOULD HAVE SMALLER FUSES

We are advocating the installation of smaller capacity fuses accessible to the consumer and in all cases, seal the entrance fuse. In the majority of trouble cases, the smaller fuse will open and can be readily renewed by the consumer; if he then inserts a penny the main fuses will blow. It would seem to me that the utility is entitled to know in order that they can inspect their meter and transforming apparatus which may become damaged due to short circuit. The duty of you gentlemen is to protect the lives and property in the towns and cities where you have jurisdiction against electrical hazards and in advocating the installation of the safety cabinet enclosing all meter wires—of sufficient size, interchangeable end wall and the sealing of this device you are decreasing the possibility of accidents and destruction of property. A great deal of discussion was created a few months ago with reference to electrical fires, presumably caused by defective wiring.

FIRE IN RESIDENCES

It is my contention and, I think you will all agree with me, that you cannot start a fire in the ordinary residence installation by actually shortcircuiting the wiring, providing proper fuses are installed at the entrance service and it is my belief that a portion of electrical fires can be traced to the popular idea that any metal material can be installed in the main line cutout to restore service. I do not think there is a public service commission in the country that will not support you gentlemen in endeavoring to promulgate these safety features. *The people look to you*, especially, and the utilities, to *safeguard their interests*, and if you permit persons, in the ma-

jority of cases, totally ignorant of the seriousness of it to destroy the protection that you and the underwriters require, are you doing your best in protecting lives and property of our citizens?

FAULT OF INSPECTORS

Even with the most elaborate precautions on the part of the utility company with reference to outside construction, accidents will occur, and as our jurisdiction ends at the point of entrance to the building, the burden of requiring safe construction falls upon you gentlemen who are empowered with authority to provide safe installations. It is unfortunate that so few inspectors have taken the initiative in insisting upon requirements that would greatly reduce the possibility of fire or accidents; and in most of the localities the central station has had to sell the idea to the inspector and point out to him the necessity of certain safe specifications. Now, which is the safest installation, and the one where the least damage occurs—the installation completely enclosing all meter wires, customers' fuses completely enclosed in a non-combustible box, neutral grounded to service side of the water meter; or the average installation with an enclosed switch, possibly fused with copper pennies, and in a great many cases the door open, allowing fuses or metal to spread and possibly start a fire, exposed meter wires, open branch cutouts and no individual ground wire?

CO-OPERATION NOT LACKING

The present situation is ideal for obtaining safe and sane meter installations; the manufacturers and utilities will co-operate, and remember, gentlemen, we all have our pet ideas regarding the type and design of service switches. I know we had a few and we scrapped them because, please bear in mind, standardization can never be accomplished without you all give up certain whims and ideas which you think should be embodied in the device. It is the writer's opinion that the safety cabinet should be handled through the contractor-dealer, manufactured by more than one company, which permits the use of the standard end wall and can be produced at a reasonable cost in order that an excessive burden will not be placed upon the consumer. It should be of sufficient dimensions to meet the requirements of the public service company. There is no question but the utilities have a right to make reasonable rules and specifications, especially with reference to installations that are required to furnish a meter in connection with, and it is not possible to obtain a 100 per cent safe installation without having the full co-operation of the central station. In reality, the utility should be more interested in the installation of a safety cabinet than the consumer

or the contractor, because they are required to furnish proper service through this device and in most states required by the public service commission to make periodic tests on the meter.

STANDARD CABINET BENEFITS

The question has been asked, "Does not the utility receive most of the benefits in the use of the standard safety cabinet?" Let us discuss some of the arguments advanced in the favor of the use of these devices:

1. Promotes safety-all fuses, wires and so forth are enclosed.
2. Reduce electrical accidents to testers.
3. Eliminates fire hazard.
4. Prevents overfusing of service cutout.
5. Improves appearance of installations.
6. Effects a standardization of meter installations.
7. Reduces opportunities to tamper.
8. Reduces the possibility of mechanical damage to the equipment and wiring.
9. Reduces cost of testing.
10. Reduces cost of maintenance.
11. Provides comparative freedom from possibility of incorrect connections when testing.
12. Permits of standardization of test leads and connectors.
13. Assures continuity of service to customer when testing, repairing or changing meter.
14. Enables the sealing of the service in the event of discontinuance or defective wiring conditions.

ANALYSIS OF BENEFITS

With reference to (1), there is no question but the consumer receives additional safety by the use of this type of installation. (2), This advantage seems to be in favor of the utility and reduces the possibility of accident to the tester. (3), This decidedly benefits the consumer. (4), The sealing of the main line fuses is of a great deal of benefit to the consumer as it prevents him from creating a fire hazard on his own property. (5), This is of advantage to the consumer. (6), Of advantage to the central station. (7), We have a great deal of trouble due to people tampering with the main line service which is of advantage to the consumer as well as the utility, and, to a certain extent, prevents theft. This equally applies to (8). With reference to (9), any device that would reduce the cost of testing decreases the operating expenses and the customer is benefited through the rate. This equally applies to the cost of maintenance. (11), We experienced some trouble with testers leaving a wire out of the meter or incorrectly connecting meters for testing. This is eliminated in the standard device as no connections are taken out of the meter and less chance of the customers' service being inter-

fered with after test. (12), Of advantage to the central station. (13), Of advantage to the consumer. (14), Of advantage to the electrical inspector and especially to the consumer, as it protects him from having current on his wiring when it is considered unsafe.

EFFECT UPON RATES

It is, of course, fundamental that the installation costs borne by the supplying company will ultimately be reflected in the rate charged for the service rendered, and the trend, as before stated, towards the elimination of all investment by the company on the premises of the customer, with the exception of the cost of the actual measuring instruments, would appear to endorse the policy followed by some companies in requiring the customer to furnish the meter accessories in question.

Arguments to the effect that these accessories are of no advantage to the customer, while they must be given weight, would appear in the final analysis unsound. The use of such accessories are of direct benefit to the customers in providing in their premises a safe and a suitable installation in safeguarding the continuity of service, and in assuring as far as possible fair dealing as between the company and all of its customers; and if the claim is admitted that the use of such accessories tend to result in reduced operating costs on the part of the company and in some cases result in a reduced investment, this must also ultimately reflect to the advantage of the customer.

The application of the safety cabinet in connection with the meter emphasizes the importance of using a device that governmental bodies or utilities can readily and economically test and adjust the meter without increased risk, also without interfering with the continuity of supply to the consumer. I am, of course, assuming such device should be so designed in order that the testing arrangement does not increase the cost and is accomplished by the arrangement of parts; such a condition exists in the standardized device.

GROUNDING OF SECONDARIES

The question of the proper grounding of secondaries is, I believe, a safety feature which has been overlooked generally by most electrical inspectors and legislative bodies. Almost the entire argument upon which grounding is based is that of reducing the life hazard. It will, however, if properly installed, reduce the danger from fire. I think the results which we have obtained have firmly convinced us that the only permanent and effective ground is direct to a water pipe system in the ground. At first sight it may not appear clear why these driven grounds give such average poor service—upon close investigation, however, it becomes very apparent as to

why they fail. I have made numerous resistance tests on this class of ground and have found the resistance to vary from five to six ohms where a three-quarter inch pipe is driven seven feet into wet ground to as high as 180 ohms on a similar pipe in the same ground after a long spell of dry weather. Such a ground can only be figured as to effectiveness under its worst condition. A fair average resistance would be 60 ohms. Considering buried plates, ground cones and similar devices, the average resistance will be about one-half of this, owing to their being buried with their active surfaces planted deeper and generally in permanently moist earth. For the same reason their maximum and minimum resistances will not vary nearly as much as in the case of a driven pipe. The chief defect of this latter class of grounding devices is their inability to withstand corrosive action of most soils for a long period of years. This, together with their higher first cost, makes them almost prohibitive for use for the purpose for which they are designed.

EFFECTIVENESS OF GROUNDS

Suppose we have a typical driven pipe ground in which we have seven feet of pipe in contact with earth in wet weather. Under these conditions our ground is only one-half its maximum effectiveness under the latter conditions of moisture. If the soil is composed of sand and gravel we lose practically all our protection in dry weather and reclaim but little in wet weather, as path of lowest resistance is then in top soil only.

RAISING VOLTAGE OF GROUND

Now, assuming a small network protected by one driven pipe with a resistance of 60 ohms—we get an accidental ground on one side of our three-wire system, or on the other wire from that to which ground is connected on a two-wire system. Immediately our ground wire and pipe is raised to 110 volts above earth potential; the potential then decreases to zero through the earth contact with the pipe. From tests made it has been found that this zero potential condition is not established until we get at least a foot away from our pipe. In other words, we have a cylinder of earth with the pipe for its axis. The outer walls of the cylinder are at zero potential and the axis 100 volts above, or below.

One of the first requirements of a successful ground connection is that it must pass sufficient current at 110 volts to at least below a branch fuse of 10 amperes. One of these pipes will not blow, under average conditions, more than a two-ampere fuse; therefore, we must provide at least five driven pipes on each section of our secondary network.

CONNECTIONS NECESSARY

The second requirement is to blow the largest fuse in our

primary network in the event of a cross occurring between primary and secondary systems. This fuse would probably be in a fair size system, 150 amperes. One driven ground would pass about 40 amperes, and we must have at least four ground connections to insure proper protection. If the cross occurs in the transformer or on a small fused branch primary line, then one driven ground will protect. This is, however, an exceptional condition, and to obtain absolute protection our grounding system must be of sufficiently low resistance to pass the heaviest current possible to obtain, and also to open up the protective device controlling the heavy current. Applying this rule we will find that to prevent our ground leads becoming charged with low potential current, due to an accidental ground on the other side of secondary network, we must provide a very low resistance path. For instance, if the heaviest main fuse of any customer is, say 150 amperes, we will need about 80 driven ground pipes to make our system self-protecting. It is sometimes difficult to get such results by this means of grounding, as it would require a ground on every pole along a stretch of line nearly two miles in length.

Now compare these crude and prohibitively expensive, as well as questionable, methods of grounding to that of grounding directly to a water main on the consumer's premises.

SAFE CARRYING CAPACITY

Assume we have a No. 8 service line and that the ground is made by tapping the neutral service line at the building bracket and carrying it down the outer wall and into the basement where it is clamped to the water pipe. We have a total resistance of at most one-fourth ohm and can pass an instantaneous current of over 400 amperes at our lowest operating potential. Here the capacity for protection is governed entirely by the safe carrying capacity of the ground and service wire. Number 8 wire will carry 60 amperes for a considerable time without dangerous heating, and we can get absolute protection under the most severe conditions from four of such grounds.

REASONS FOR NOT GROUNDING

Proper grounding has been recommended by the National Board of Fire Underwriters, National Electric Light Association, Bureau of Standards and the American Institute of Electrical Engineers, that is, on circuits where the voltage does not exceed 150. It is my understanding that one of the reasons in the past for not grounding to the water service has been due to objections from municipal authorities who assumed that this might cause electrolysis. The grounding of A. C. service will not result in any electrolytic action and should these authorities desire further advice I am sure that

the Bureau of Standards or the American Water Works Association can advise them that no damage would result. For the information of those present would say that the Public Service Electric Light Company of New Jersey have made a ruling that they will not furnish service unless the customer installs the ground wire. Several years ago a consumer refused to install this ground wire and was not given service. The company's requirement was upheld by the commission after considerable expert testimony was taken.

SECONDARY CIRCUITS

I wish at this time to quote Prof. A. F. Ganz, of the Stevens Institute of Technology, in which he advises that with the secondary circuit of the transformer grounded it is improbable for voltage to exist between the ground and any part of the secondary circuit wiring, which is greater than the normal secondary circuit voltage. No matter in what way high voltage lines are made to come in contact with the low voltage secondary circuit wiring. "This experiment illustrates that with a secondary circuit of a transformer grounded it is hardly improbable for a voltage to exist between ground and any part of the secondary circuit wiring which is greater than the normal secondary circuit voltage, no matter in what way high voltage lines are made to come in contact with the low voltage secondary circuit wiring.

"It is, therefore, seen that theory proves and experiment illustrates the fact that to ground the secondary circuit of a transformer protects this circuit, which is the house wiring, from being maintained at a high and dangerous voltage from ground, and that, therefore, such grounding is a safety measure which protects persons from dangerous electric shock, should they some in contact with any part of the house wiring when the secondary circuit has come in accidental contact with a high voltage source. The ground connection behaves in fact like a safety valve, causing current to pass to ground only when an abnormal electric pressure is set up by accident between the house wiring and ground, thus relieving the abnormal pressure. It is clear that under normal conditions no current whatever flows over the ground wire to the ground connection.

"It has also been claimed by some that grounding transformer secondaries increases the fire hazard to buildings, and this has been put forward as an argument against grounding. Experience in cities where grounding has been practiced for some years does not, however, bear this out, but on the contrary *in many places* it has been found that the number of fires

from electric wiring and from lighting have been actually reduced since the grounding connections were installed."

GROUNDING SECONDARIES

I also wish to advise that several years ago the Public Service Commission of New Jersey engaged Prof. Malcolm MacLaren, of the School of Electrical Engineering of Princeton University, to make an inquiry and to report upon the matter of the grounding of transformer secondaries. His conclusions were that the transformer secondaries of public supply companies should be grounded in all cases where the potential does not exceed 250 volts; also that the ground connections be made to the water mains whenever these are available and that in all other cases continuous ground wires be used and that these be grounded at frequent intervals. I hardly think it is a question whether we should or should not ground our secondaries, the issue being whether the ground is effective, as a poor ground is a menace and in a good many cases worse than no ground at all.

INDIVIDUAL GROUNDS

It has been our experience that the method of requiring individual ground wires is highly satisfactory and believe there are several inspectors present who will corroborate me in this statement with reference to reduction of life and fire hazard. I am very glad to state that on several properties where we operate we have installed over 8,000 individual ground wires which up to date have fully justified their use and practicability. This method of grounding has also resulted in decreasing the number of meter burn outs, due to lightning, as well as affording complete protection to our various consumers.

CODE NOT SPECIFIC

A summary of the grounding methods seem to indicate that there is no question but what proper grounding is one of the best safety measures to prevent life and fire hazard in connection with meter installations. It is unfortunate that the Underwriters' Code does not be more specific in its requirement, that is, if the Code required that an individual ground wire must be installed on all new installations and connected to the source side of the water system, it would be a decided step for the betterment of safety. It is the writer's belief that no serious trouble has ever been experienced regarding grounding providing the grounds are effective. On account of the great extent of water pipe systems and the good conductance of their joints, they constitute the best means of grounding electric circuits and equipment. The resistance of water pipe grounds is in general less than 0.25 ohms; the

latter figure representing the maximum value by far the larger number measures 0.1 ohm or less.

ALTERNATE GROUNDING

Where alternate means of grounding are used, such as well-casing, drains and other underground metallic structures of only local extent, care should be exercised because many such grounds which appear to be good and sufficient for protective purposes turn out to be very poor in certain seasons of the year, due to drying of the soil, especially when the soil is sandy. Driven pipe grounds, particularly in light dry soil, are rather uncertain, and consequently efforts should be made to have the pipe extend far enough into the earth to reach permanent moist soil. In all soils saturate the earth around the pipe with brine. The use of grounds other than the water piping system should be used only after it is found impossible to connect to the water system.

GAS PIPE HAZARD

I wish to say at this time a word of caution with reference to connecting ground wires to gas pipes. This should not be permitted under any circumstances, due to the danger of igniting gas in case the pipe is broken or burned.

I might say as a summary of this paper that we have installed over 30,000 safety service cabinets, all of which have been purchased and installed by the consumer. These installations are completely enclosed in metal, including the wires to and from the meter; our percentage of protection ranging from 15 to 85 per cent. of the number of meter installations completely enclosed. I might mention for your information that our largest property is now approximately 40 per cent. protected, all of which has been accomplished in a matter of about three years. I believe these results are good examples of what can be accomplished in every city in the country, providing close co-operation can be obtained by the city electrical departments, contractors and utilities.

ALL-SAFE SWITCH

There has been some agitation in favor of the installation of the all-safe switch in connection with meter installations. It is the writer's opinion that this type of device is not applicable to meter installations as the application is not similar to that of industrial use, in view of the fact that we are required to connect and test the meter, also to make special tests in order that adequate service can be furnished to the consumer. It would seem to me that the consumer would have adequate protection in view of the fact he can *open the switch* which, of course, cuts off all current from *the branch* cutouts, and in case of entrance fuses these are

replaced by persons who are thoroughly familiar with the dangers. One of the first rules is that the tester must at all times have fuse protection. This rule was made after several testers were burned by not having proper fuse protection. In case of the service switch where the fuse is dead when the switch is open, the source side being connected direct to the switch, believe that such a condition is exceedingly dangerous to testers, as it is very possible to get a lead or a screw driver against the grounded box. You may take the position, the tester can take his source of current for meter testing behind fuses and not on the switch. It has been our experience that it is next to impossible to require the tester to make connections that are not convenient, and he will invariably obtain his voltage for the phantom load by hooking leads on the switch with the fuses on the primary side of the transformer bank as his only protection. It is needless for me to say that a serious accident may happen should he make a short circuit.

AMMONIA EXPLOSIONS

Results of Experiments Conducted in Refrigerating Plants—Ice Cream Manufacturing Hazards

Refrigerating engineers have gotten in the habit of minimizing the importance of explosions in such plants by giving a chemical explanation attributing the explosion to hydrogen gas liberated by a decomposition of ammonia, or some similar cause. Tests show that pure ammonia vapors mixed with air in certain proportions will explode if ignited. For practical purposes it is immaterial whether the chemical explanation attributes the explosion to hydrogen gas liberated as described or to some other cause.

Explosions in refrigerating plants have become so frequent of late that renewed attention is being called to this hazard; which it would appear is not fully realized. Besides disasters in what are properly classified as refrigerating plants, there have been several breakdowns in ice cream manufactories and similar establishments within the last few weeks, where ammonia is used in the process. Taking a Michigan plant as an example, it was found that rupture occurred in the brine cooler which was located in a pipe tunnel adjacent to the boiler room. The cooler was constructed of a boiler plate cylinder with welded joints, both longitudinally and at head where wrought iron tube sheet attached. This tube sheet had an outside lug rim to which cast iron heads were bolted. The brine circulated inside the tubes and cast iron heads. Ammonia circulated in the shell. The shell of cooler failed at the longitudinal welded joint for its entire length and also failed for three-fourths of the circumference where welded to tub sheet, so that the shell was laid open by the rupture. The welding was very poor in many places and did not extend through one-half of the joint.

The normal pressure in the cooler was between 10 and 25 lbs. Both inlet and outlet ammonia valves were closed at night before rupture occurred and were found closed afterward. The brine circulated pump had frozen, also the brine in the cooler tank froze. The valves were closed to allow the tank to thaw slowly under the influence of ordinary temperatures. Workmen had disconnected the pump at one end of the brine cooler, finding both frozen, and were instructed to replace as before. The plan was to allow the tank to thaw slowly. This tank constituted only a part of the refrigerating system and the remainder of the system could be operated though hampered some *without the use* of this tank. The workmen were engaged in

replacement when the accident occurred. The recording gauges of the system showed no abnormal rise in pressure.

CLAIM NO OPEN FLAME USED

There is no evidence of a heavy disruptive explosion. The cooler tank apparently failed at the welded joints and opened from an increase of internal pressure which releasd the ammonia. Claims are made that no open flame was used by the workmen. There was very little evidence of fire in the tunnel where the rupture occurred, and there is a difference of opinion as to whether the ammonia gas ignited, although the combustible roof of the boiler room and other combustible material near the tank was burned. The dead workmen were found charred, which indicates that the gas must have burned back into the tunnel. The theory advanced is that the hot fires under the boilers ignited the ammonia gas. The boiler house attendant states that the first knowledge he had of the accident was a slight puff and the showing of heavy white clouds of ammonia gas coming through small openings in the top of the pipe tunnel adjacent to the boiler room. These fumes were so thick that the firemen had difficulty in fighting the fire and recovering the bodies, finally having to use gas masks.

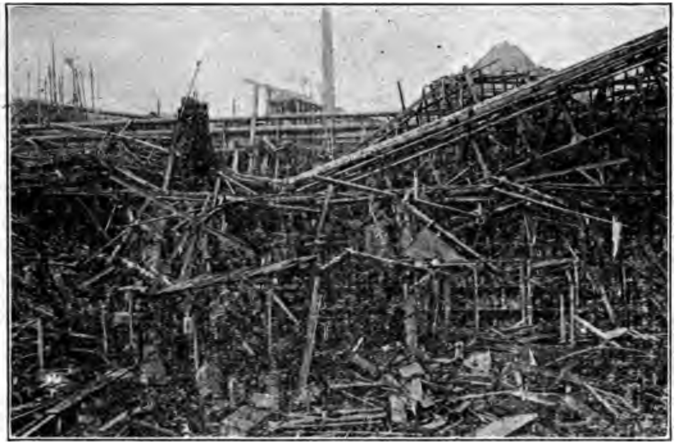
This system of refrigeration does not use an attached commercial ammonia cylinder. Ammonia is placed in a large permanent cast iron cylinder attached to compressor and used as needed.

SUMMARY OF CAUSES OF ACCIDENT

Class of Accident	Number of Accidents
Leaky joints	61
Bursting pipes	28
Liquid valves shut off on receivers	11
Liquid in compressors	9
Cylinder heads blown out without definite cause	9
Gaskets blown out	9
Defective valves	8
Accidents prevented due to safety valves blowing	7
Generators burst	6
Ammonia leaks, misc.	4
Pumping air with refrigerating machines for testing	3
Packing blowing out	3
Shutting off water supply in some manner	2
Brine cooler	1
Explosion of ammonia vapors mixed with air	14
	175

Experiments conducted under the direction of Arthur Lowensten of Wilson & Company, Chicago, demonstrate that ammonia

gas, mixed with air in certain proportions, when ignited will propogate a flame. Special apparatus has been designed which enables one to determine the conditions under which ammonia will burn, when all known mixtures with air are brought together under suitable conditions; also known mixtures of oxygen and ammonia. These tests were made in steps of 0.5 per cent.,



WHAT HAPPENS WHEN CHEMICALS LET GO

using mixtures varying from 1 to 100 per cent. of ammonia in air, both dry and saturated with water vapor. The results under these conditions were that no visible form of burning was evident until the region of 11 to 13 per cent. of ammonia was reached. It was found that a small yellow flame was produced at 11 per cent. ammonia in air which increased in size with increase of ammonia content until at the proportion of 13.25 per cent. of NH_3 the burning was complete. At this concentration a yellow flame completely enveloped the glass containing vessel and the combustion was sufficiently violent to shatter the vessel. Above this percentage mixture, no apparent burning occurs. It appears that the limits of inflammation are rather narrow. It is to be understood that the mixture of air and ammonia mentioned in the experiment cited above were the conditions which obtained in that particular set of experiments.

These experiments were made in a darkened room with a black *background,* so that the appearance of flame could be readily

observed. It was even necessary to use a heavy glass shield to protect the operator. After the desired mixture was satisfactorily prepared, electrical connection was made by means of an induction coil and platinum wires were inserted into the vessel, forming an arc, causing the spark to pass between the platinum knobs of the electrodes.

FIFTEEN PER CENT. AMMONIA NOT SAFE

Another set of experiments, using similar apparatus, were made, but instead of attempting ignition of the mixture with an electric spark, an electrically heated platinum wire was used. As in the preceding, tests were made with a mixture of ammonia and air, varying from 1 to 100 per cent. of ammonia in air. Results were that up to 5 per cent. of ammonia in air no apparent change took place, except the formation of condensed moisture on the sides of the vessel.

From 5 per cent. ammonia to 13 per cent. ammonia in air, there appeared, besides condensed moisture, dense white vapors.

From 13 to 15 per cent. it was observed that the platinum wire remained incandescent, even after the current was turnd off and in addition considerable white vapors were formed.

After 15 per cent. it increased in size with increasing percentages of ammonia up to 19.58 per cent., at which point the mixture violently exploded upon ignition.

Under the condition, mixtures between 19.58 and 26 per cent. of ammonia in air were explosive. The explosions were violent, sufficient pressure being generated to shatter the glass container.

From 27 to 58 per cent. of ammonia in air, the platinum wires remained incandescent after breaking the electrical contact.

From 58 to 100 per cent. no apparent reaction took place. The wire glowed more dimly under these conditions and ceased to glow immediately upon turning off the current.

POSSIBLE FORMATION OF OZONE

These results seem to show conclusively that ammonia will burn when mixed with air in certain definite proportions, and when the proper mixture is ignited the burning is sufficiently rapid to cause an explosion. There seems to be a difference in the percentage mixture which will explode. It was found that 13.25 per cent. ammonia in air, when ignited by an electric spark, exploded, and that mixtures betwen 19.58 and 26 per cent. ammonia in air exploded when ignited by an incandescent wire. This apparent discrepancy is being studied further. It is possible that a complex reaction takes place when using the electric spark and it has been suggested that possibly the formation of ozone and the interaction of the latter with ammonia might occur.

Emphasis must be laid upon the fact that the burning point was not due to the continuous presence of the spark, or heated

coil, inasmuch as the explosion was instantaneous upon the closing of the electric circuit for a second.

From the above it is also evident that the burning was not due to the decomposition of ammonia and the subsequent burning of the hydrogen. The ammonia employed for combustion tests was tested 100 per cent pure and was made from the highest purity ammonia salts of Kahlbaum's manufacture after repeatedly recrystalizing the salts to be sure that the very purest form of ammonia was employed in this experimental work.

As a result of the above experiments it is suggested that in order to minimize the danger of fire in the ice machine room in case a cylinder head should blow out, that open gas jets and arc lights be dispensed with and that the room be well ventilated.

It is not to be construed that the sudden release of ammonia into air is the only possible cause of a fire of the character which results at times. As a matter of fact, it is Mr. Lowensten's opinion that lubricating oil in a very finely divided state at an elevated temperature and pressure when suddenly released into the atmosphere would very rapidly become carbonized and might ignite spontaneously. In this connection, Dr. P. H. Conradsen, of the Galena Signal Oil Co., has published a very interesting article describing the effect of air when suddenly brought into contact with oil in an atomized condition in connection with locomotives operating with superheated steam. In addition to these possibilities, there are, of course, others which might cause fire under a given set of local conditions.

REPORT ON ICE CREAM PLANT

Following is a report on explosion of ammonia and air mixtures in the plant of the Jersey Ice Cream Company, Lawrence, Mass:

There was a factory with ammonia refrigeration in a four-story brick building of reinforced concrete construction. Room in which fire occurred was front portion of basement, partially enclosed by brick wall. Area of room 45x30 ft. This room contained one 15-ton ammonia compressor, also one each 30 and 40-ton ammonia machines and a 300-gallon ammonia receiving tank. Room also contained a small heating boiler and an open-fire coal water heater, neither of which was cut off in any way. There were also in the room three motors with open switches and starting devices. The room was lighted by elctricity without vapor-proof globes. The wiring was well installed.

Compressors were operating normally when suddenly the discharge pipe from the 15-ton compressor broke without warning and the ammonia vapor under 180 lbs. pressure discharged into the room. The engineer escaped and warned office occupants *directly above,* who escaped immediately and just before a mild

roar similar to a light explosion took place in the basement (time between break and explosion probably two minutes). A flame was noticed for a while, which charred the stairways and window sills, which constituted about the only combustible material in the room.

Conclusions: The facts of this accident show that the vapors if discharged suddenly under pressure from an ammonia compressor, in the presence of open fires, are inflammable. The boiler and hot water heater should have been cut off from the compressor room.

SYRACUSE COLD STORAGE COMPANY

A plant used for cold storage and ice cream factory. Buildings brick and fire proof construction except frame condenser roof house. Fumes were noticed pouring from a break in the 2½-inch discharge pipe from a 75-ton ammonia compressor. Break occurred between compressor and oil trap. Weather warm and humid, 92 deg. F. The escaping ammonia exploded quickly. It is not definitely known whether the mixture of air and ammonia was ignited by an electric spark from one of the numerous switches in the room, or from contact with the fire of the boilers which were in the same room and not cut off. Normal pressure about 150 lbs., at a temperature of about 220 deg. F. Fire communicated with the frame condensing house and other combustible material in the room.

The report indicates that after the gas was first ignited it flashed back to the crack in the pipe and the mixture then exploded, ripping open the discharge pipe. Fumes are said to have been seen coming from the break before the flash and subsequent explosion.

It was suggested that the highly heated air in the compressor room, due to the intensely hot weather possibly expedited the explosion.

BIRMINGHAM ICE COMPANY

The suction valve on a 70-ton ammonia compressor fell into the cylinder, causing the cylinder head to blow out. Ammonia vapor from compressor was discharged into room about five minutes, at which time the fire developed in the gases at the roof, apparently spontaneously. Compressor was operating at 200 lbs. pressure. Temperature of water jacket surrounding cylinder usually registered 200 deg. F.

One explanation of cause of fire suggests the possibility of an electric arc induced through the conducting medium of the ammonia gases.

EXPERIMENTS BY LABORATORIES

Underwriters Laboratories, Chicago, conducted some experi-

ments relative to explosions resulting under conditions where ammonia was present. A few experiments were conducted on a small scale. The experimenters were able to obtain explosions by conducting the gas from C. P. ammonia water into a small flask so as to give a mixture of air and ammonia gas (about 20 per cent. NH_3 by volume) and igniting by means of electric spark and also by means of a red to white hot wire. It appears that the explosive range is narrow and that the mixtures are not easy to ignite.

These results make doubtful the old theory that ammonia is not capable of causing an explosion.

DANGER OF EXPOSED FLAME

The New York Board of Fire Underwriters made a report on an ammonia explosion in the compressor room of the Merchants Refrigerating Company, New York, arriving at the following conclusions:

All exposed fire and flame must be excluded from the ammonia refrigerating machinery rooms and other places subject to the accidental discharge of large quantities of ammonia.

The spark which caused the explosion of ammonia vapor in this case was apparently due to an electric arc established between two bare metal terminal lugs of a 7,500-volt oil switch. A space of 8 inches across a slate surface formed the insulation between the terminals. This insulation seems to have been reduced sufficiently by the moisture laden vapors resulting from the discharge of ammonia and cooling jacket water to establish an arc between the terminals as evidenced later by fused copper thereon.

An insulating covering is therefore considered essential, for all live metal parts of every electrical equipment having a potential in excess of 600 volts.

All electrical equipment not essential to the ammonia refrigerating machinery room should be separated therefrom and consideration should be given to the advisability of preparing special requirements for the electrical equipment in ammonia refrigerating machinery rooms.

There should be a service switch controlling all the electrical equipment in a refrigerating machinery room; this switch should be outside of the room and located where it can be safely reached and opened in case of an accidental discharge of ammonia.

USE AND OCCUPANCY ADJUSTMENTS

What This Insurance Covers—Interpretation of Forms—Literal Application of Clauses in Policies—Present-Day Conditions Aggravate Adjustments

By H. B. Fargo, Assistant Manager Western Adjustment and Inspection Bureau, Before Insurance Club of St. Louis

Use and occupancy has grown to be a very important feature in the business of the progressive agent and is probably less understood than any other branch of the insurance business. So-called use and occupancy—or business interruption insurance—is intended to enable a going and profitable business to hold its organization intact during such time as the property may be unproductive as a result of fire or other hazard insured against. There is considerable doubt in the minds of many as to just what elements should be covered, and I cannot lay down any hard and fast rules that will fit every case. If the agent will fix firmly in his mind that "use and occupancy" insurance is not available as to items which should be paid for by ordinary insurance, it may, perhaps, be easier to prepare his use and occupancy coverage.

The items usually sought to cover are: (1) profits; (2) salaries of officers and executives; (3) those expenses which will continue in spite of destruction of the premises, such as taxes, salaries of buyers, (for good ones are not easily obtained), and a going concern could not afford to let them go pending reconstruction or repairing of the plant); salesmen, for the same reasons; certain office and shop help might also be indispensable. Whatever is intended to be covered under this heading should be clearly set forth in the policy. This item might also include penalties and incident legal expenses for inability to fulfill contracts made prior to the fire, and which were prevented as a result thereof; also royalties, interest on investment, etc.; (4), factory payroll for a limited time, where it would be highly desirable to hold the force intact pending repairs. This, too, if intended for coverage, should be incorporated in the policy form.

INTERPRETATION OF FORM

There is not a little lack of agreement among adjusters in their interpretation of the use and occupancy form generally in use at this time. Only recently two adjusters interested in the adjustment of a use and occupancy loss disagreed as to the scope of the clause which requires the assured, as soon *as practicable,* after any loss, to resume complete or partial *operation of the* property, and to make use of other property,

if obtainable, if by so doing the amount of loss will thereby be reduced. One of these adjusters in the absence of the other had authorized the assured to utilize certain buildings owned by them, for temporary manufacturing purposes, which would necessitate alterations costing many thousands of dollars, and agreeing with the assured that the amount so expended would be a part of the use and occupancy loss and would be paid for by the companies carrying the use and occupancy insurance. The question was submitted to the other adjuster, who promptly advised the assured that he could not agree to the proposed action, unless the loss would be reduced as a result thereof. It is quite obvious that under the unlimited authority given by the first adjuster, the expense might have resulted in greatly increasing the use and occupancy loss, and was not warranted under the conditions of the contract. Please bear in mind that I do not regard the clause referred to as being entirely equitable, but it is a part of the contract, and so long as this is the case the adjuster must conform to it.

WHEN TO MAKE ADJUSTMENTS

I am firmly convinced that no use and occupancy loss should ever be adjusted until the plant has resumed normal operations or is in condition to so resume, or it has been definitely established that it will not resume operations; I am also convinced that many items which are properly insurable under use and occupancy policies should not be paid for unless the plant resumes operations. If the loss is settled on an estimated basis, it is of course with the expectation (at least on the part of the adjuster), that the plant is to resume operations as soon as possible, but after the loss has been adjusted and paid, if the assured decides to not rebuild or resume operations, it is too late to recover for those items which were improperly included in the adjustment and paid for, on the theory that the plant was going to resume business.

To my notion—and with no desire to criticise the framers thereof—the present uniform use and occupancy form presents some features that will sooner or later be a source of much trouble and possible litigation. One paragraph reads:

"If the said buildings, or machinery or equipment (insert 'or stock' if policy is to cover replacement of same, otherwise policy shall not so cover) contained therein, be destroyed or damaged by fire occurring during the life of this policy so as to necessitate a total or partial suspension of business, this company shall be liable under this policy for the actual loss sustained to net profits on the business which is thereby prevented, and for such fixed charges and expenses as must *necessarily* continue during a total or partial suspension of

business for not exceeding such length of time as shall be required with the exericse of due diligence and dispatch to rebuild, replace or repair such part of said buildings and machinery and equipment (insert 'and stock' if covering replacement of same) as may be destroyed or damaged, etc."

The language used with reference to "stock" in this paragraph I regard as ambiguous, if not really dangerous. There can be no doubt in the minds of the reasonably well informed on this subject that it was never intended to cover or insure the physical stock itself under use and occupancy coverage, and yet the language clearly infers that by inserting the words "and stock" in the blank space the "policy is to cover replacement of same, otherwise policy shall not so cover." If a dishonest claimant should sustain such a loss and demand payment as to the physical stock, I personally entertain little doubt as to what the learned Missouri courts would decide.

Another paragraph of this form, which I believe is fraught with danger is that which reads:

"It is a condition of this insurance that the daily production at the time of the fire shall be based upon the average daily production of all plants or properties herein described for the 300 days of full operation next preceding the fire."

LITERAL CLAUSE APPLICATION

The literal application of this clause in the adjustment of a loss, is apt, under certain conditions, to create a great injustice either to the assured or the company. If the business of a claimant had been reasonably stable for the 300 days immediately preceding the fire, substantial equity might follow its application. Please note, I say *might* result in substantial equity. Even under a fairly distributed business for the 300 preceding days, the literal application of this clause could produce highly prejudicial results. I will illustrate this by reciting very briefly a pending adjustment which, before it is finally closed, may be decided by the courts: Policies aggregate $750,000, providing a maximum daily liability for total suspension of $2,500, and covers two plants producing the same character of merchandise, but widely separated as to location. One of these plants is totally destroyed, and in taking up the use and occupancy adjustment, it is found that approximately 65 per cent. of the production of the two plants applies to the destroyed plant, but because of peculiar conditions, which I shall not take up the time to go into details about, the burned plant has been operated on a basis that produced practically no profits whatever, while the other plant has been enormously profitable. As the case stands, *after* the destruction of the unprofitable plant, the owners may *still continue operation* of this smaller plant and show ap-

proximately the same profit that was earned when they operated both plants. The assured contends he is entitled to 65 per cent. of $2,500 for each day of total suspension of the burned plant, which claim is denied by the companies' representatives. It would be interesting to know whether, if chance had destroyed the profitable plant, the assured would have been willing to accept 35 per cent of $2,500 for each day of total suspension, and it would be equally interesting to know whether this would not then have been the contention of the adjusters.

PRESENT DAY EFFECT

In a period of depression such as many lines of business are now undergoing, and which it is highly probable will be even more aggravated in the next twelve months, the literal application of this clause will prove a real blessing to some concerns when the loss occurs. On the other hand, a loss occurring during a period of rapid expansion might result in an adjustment highly beneficial to the companies, in applying this clause. It is desirable, of course, that the contract should provide for an equitable basis for determination of the loss, but I feel that a 300 days' period is not the best that might be devised.

The "partial suspension" clause of the policy is likewise such as may produce a great—and undoubtedly an unintentional injustice. The clause provides that the

"Per diem liability shall not exceed that proportion of the per diem liability which would have been incurred by a total suspension, which the decrease in production bears to the full daily production at the time of the fire."

Let us suppose a policy of use and occupancy providing for a maximum of $1,000 per day for total suspension. The net profits and fixed charges are ascertained to have been an average of $1,000 per day for the preceding 300 days, but on a basis of $2,000 per day for the 60 days next preceding the fire, $1,500 per day for the 90 days preceding the 60-day period, and $300 per day for the other 150 days. But for the fire, it is agreed by both the adjuster and the assured that the profits and fixed charges would have continued indefinitely at $2,000 per day. The fire occurring causes a 50 per cent. decreased production of the plant for 30 days. You will note that with the production of the plant curtailed 50 per cent. as a result of the fire, or $1,000 per day, it is still producing a profit and fixed charge account to the amount of $1,000 per day, or just the same figure that was averaged for the 300 days immediately preceding the fire, and therefore, under the terms of the contract, the company is liable for nothing. Certainly *neither the agent* or the assured ever contemplated being

placed in this position, and by the same token it is equally true that the company had no intention of selling a gold brick.

Other objections might be pointed out, but I feel I have already taken up my allotted time, and will bring this to a close by reciting a personal experience in the adjustment of a use and occupancy loss which was adjusted at many thousands of dollars less than a strict adherence to the contract would have permitted the assured to recover, and yet the adjustment was entirely satisfactory to the assured, and provided him with complete coverage as to actual loss sustained, which only emphasizes my contention that the basis of adjustment should not be so fully predetermined as is done in the present-day uniform form:

Insurance $180,000, based on 300 days at $600 per day.

U. & O. value, based on assured's records, $421,506.10.

Loss agreed:

Proportion of U. & O. applying to destroyed unit, .50425 per cent., or $302.55 per day.

Agreed total suspension, 165 days at $302.55........	$49,920.75
Deduct, as agreed, for unusual manufacturing conditions existing regarding supply of raw materials	10,622.08
Agreed loss and damage	$39,298.67

FLOUR MILLS

Causes of Fires Analyzed—Many Inherent Hazards Avoidable —Care and Good Housekeeping Essential

By J. E. Anderson, Minneapolis

There are the so-called inherent hazards of the mills, but these so-called inherent hazards when analyzed show somewhere there was a fault that could have been corrected. The general hazards of a mill come under the headings Power, Machinery, Light and Heat.

Steam Power: Many fires are caused by poor installation of steam power. Boilers should be set in brick covered by brick or other good fire-proofing material. There should be no wooden timbers or beams in the boiler setting, for surely in time the accumulated heat causes this timber to burn. There should be a good clearance between boiler housing and any wood partitions or walls. The steam dome and all pipes above the boiler should be at least 48 inches below frame roof of boiler house stack; preferably a brick stack outside, or if metal on a brick base. If metal stack goes through frame roof a clearance of 12 inches at least should be kept and 15 inches from wood. The hazard of a metal stack through frame roof is such that insurance companies make a charge for it no matter what the clearance is.

There is no particular hazard from the steam engine if the engine room has a cement floor and no dirt or oil or oily rags and waste are allowed to accumulate.

GAS AND OIL FUEL

Gas Engine Power or Oil Burning Engines: This kind of power in the last 15 or 20 years has become quite prevalent. The best installation, of course, is putting this engine in a fireproof room and using a pump feed engine; the tanks to be buried and underground outside the engine room. Any installation less safe takes a charge by insurance companies. However, if not installed as above, the engine room must have a cement floor, engine pump feed, tank buried and underground 15 inches from building and installed so any surplus oil drains back into the tank. Exhaust pipe must have a clearance of twice the diameter of pipe when it goes through wooden walls and the exhaust to go to an exhaust pot underground. The *danger of oil* power is from the oil or gasoline; therefor, none

should ever be in the engine room. Gravity feed engines are prohibited.

The modern power is electricity and with it comes a new set of hazards. While nobody knows what electricity is, we do know that it is governed by laws which must be obeyed or disaster follows. This power is different somewhat in its application from water, steam or oil power; inasmuch as with steam, water or oil the power is largely one unit in one location. With electricity it can be wired to any and every part of a plant and a motor of just the right capacity used to handle the load. Therein lies a hazard because many of these motors are located in inaccessible places. When they become overheated they are a serious menace. Motors using low voltages and of induction type (that is, having no brushes or sliding contacts) are permitted in clean dry locations. Where dust accumulates on them they must be enclosed in dustproof, flashproof enclosures. All brush motors must be so located.

All high voltage motors must be enclosed and special consideration given to installation. The prevention of fire by electric motors is to have wire sizes large enough and fuses of proper rating, low enough to protect, and keeping motors clean and free from dust.

Machinery: Almost every machine used in a flour mill has been the cause of fires, with the possible exception of reels. We have had several fires in the fan bearings. Eliminating the machinery hazards means having shafts in line. Bearings well babbitted and kept cool; a good grade of oil used, and in this connection our companies report that in the last few months we have had more fires from hot bearings than usual. We find in many of these cases an inferior grade of lubricating oil was used, which is surely poor economy. Ring oilers, wick oilers and lately ball-bearing shafting and machinery are reducing power costs and the fire hazard in bearings.

The mill stream should have an automatic magnetic separator ahead of it to remove all metal from the grain. As metal goes over the break rolls a flash or explosion follows which is often carried to a cloth dust collector and a fire results. In this connection I will say that the all-metal dust collecting system is replacing the cloth or stacking type in many mills. This is a reduction in the fire hazard and a credit in the insurance rate is given therefor. For screeners, grinders and fast running machines special installation is necessary to guard against their hazards. Fast running fan bearings should be inspected to see that the shaft does not ride the collar, as this friction will soon cause ignition. This is especially true of the old wooden case fans and fans on cleaners of most types.

Wooden pulleys, as you know, are prohibited where they

are hidden, especially in the heads and boots of the elevator legs. Experience has shown that friction, where wood is concerned, soon raises the temperature to the ignition point. The elevator legs should be examined occasionally to make sure that no nails or screws protrude inside for the buckets to strike. This condition is dangerous. All conveyors should empty exactly at the end, because we have had many fires from the product crowding causing friction and ignition. Bleachers are high voltage electric generators of the direct current type and should be enclosed in special bleacher enclosures and the frame of these machines thoroughly grounded.

SOME LIGHTING HAZARDS

Lighting the Mill: No open lights should be used. Lanterns are permitted under restrictions. Electric lights to be installed as per the Electrical Code which covers the following points: All fuses enclosed, with no open connections. Not over 12 lamps on a circuit. Where portable lamps are used the wire feeding these to be heavily insulated and lamp guards used. Many explosions and some fires have resulted from putting an unprotected lamp in a flour bin, the breaking of the lamp resulting in an explosion and often a fire. You all have heard and possibly know of someone lighting a match to look into a bin and its effect. Do not use nitrogen or other gas filled electric lamps except in office and power house; these lamps get exceedingly hot and have been known to ignite the dust on them.

Heat: You all know the danger of stoves unless they are safely installed. This means good brick chimneys from foundation up; short stove pipes well looked after and a protecting metal plate under the stove with an air space between the stove and floor. Small steam generators must have an air space under them.

Oil heaters must not be used in the mill; steam heat is the best heat. Hot air plants gather too much dust on top. Steam pipes, when they go through walls must have good clearance because if the heat is not dissipated the wood soon loses its life and becomes "punk," in reality a low grade charcoal, and will ignite at the same temperature at which charcoal is made. Cleanliness, they say, is next to Godliness; and surely good housekeeping is one of the greatest factors of safety in a flour mill. There are several features of this, namely: general cleanliness; good oiling and sweeping; keeping dust and dirt swept down from rafters and beams; keeping the bearings free from dust and grease; oily waste picked up and put in standard waste cans; all out of the way corners kept clean. Repairing of leaky heads and boots and spots so rags and sacks stuffed

in to plug up leak will not be necessary; employing of competent help and enough of it to look after the operations and safety of the plant; posting of "No Smoking" signs and enforcing the edict.

Fire prevention is not complete in itself because under certain circumstances or causes it fails. Then its twin brother, Fire Protection, should step in and take up the load. Foremost comes our old friend the water barrel and buckets. These are a requirement, as are also Pyrene or similar extinguishers for oil engines and electric motors. Chemical extinguishers of the soda and acid type are good. They should be emptied and refilled yearly. Standpipes and hose are considered very good and a credit in the rate given if they are standard.

VALUE OF WATCHMAN

Every mill should have a fire axe on each floor, so that fires in spouts, legs and bins can be reached hurriedly. At the larger mills the watchman on duty when plant is shut down, reporting to central station or carrying a clock is an excellent protection. The automatic sprinkler installations are of course the best fire protection measures yet devised, but these usually can only be installed in the larger mills. The careful man is, of course, the best prevention and protection for any plant. He will forestall danger; he will see and correct conditions before they become dangerous; he will keep weeds and grass cut outside; he will replace shingled roofs with less hazardous material because he realizes that shingle roofs have no place in mill construction; he will see that all fire-fighting equipment is in good condition and in the right place; he will see to it that he has adequate help of the right kind; that repairs and replacements are made at the right time. In short, he will exercise the same care in the safety of the plant that he does in the business which the plant makes possible.

The foregoing does not by any means cover the subject of prevention because new conditions bring new problems. In milling new conditions rise from time to time, each bringing its own hazards, but if a little forethought is given to these problems as they arise I know we can cut down the fire waste which is such a direct burden on industry.

MOTION PICTURE FILMS

Efforts to Regulate Use of Inflammable Film—Non-Theatrical Entertainment—Censor Boards to Determine if Films Are Slow Burning

By Charles Heath, Superintendent of Insurance, Winnipeg

It is apparent to all that we are on the threshold of a material increase in the use of the deservedly popular motion-picture machine through its application to all forms of educative and illustrative work. Not only does this apply to weekday and Sunday schools, colleges and lectures, but it forms a means of illustrating salesmen's talks before conventions, demonstrations at exhibitions of factory processes, and is being increasingly used for home entertainment, not forgetting its use in toy form for children.

In order to obtain the true perspective in relation to the movement in its relation to safety to life or property, it is fitting to allude to the characteristics of the product known as motion picture film.

The bulk of the film in use today is a product known as nitro cellulose. Cellulose, with a high degree of nitration, forms the well-known explosives used in warfare, while the product used for motion-picture films has a low degree of nitration. The peculiar inflammability of this type of film is due to the fact that, chemically speaking, sufficient oxygen is present within the structure of the film itself to help support combustion or to continue decomposition without the aid of outside air.

Another point to be considered is the different effect produced by the burning of film under two conditions met with in practice

1. If there is free access of air to the burning film, it burns very rapidly with a yellow flame and little smoke.
2. If an attempt is made to confine the fire to a comparatively small container, combustion consists mainly in decomposition which forms a very dense yellowish gas having an acrid odor. It is also to be noted that decomposition may generate sufficient heat to cause these gases to ignite, and, in fact, when large quantities of film are concerned, such as in an exchange building, explosive mixtures have been formed with disastrous results.

It is not necessary to allude further to the highly dangerous composition of this product except to state that before these dangers were sufficiently realized, very many serious fires and panics occurred.

SERIOUS FIRES

The first fire to bring out the dangers of film occurred in Paris, France, when approximately two hundred persons lost their lives. This has been followed by numerous other fires that have occurred all over the world.

St. Petersburg, March, 1911, ninety persons burned to death, forty injured.

Castellon, Spain, November, 1918, twenty children trampled to death and twelve injured.

Velennces-Sur-Rhone, France, July, 1919, fifty-three children and twenty-one women killed.

These, I think, sufficiently illustrate the tremendous risk which is entailed with the use of this highly-dangerous product when not accompanied with all possible safeguards.

PRECAUTIONS TO BE TAKEN

The result of these lessons has been that regular moving-picture theatres in any well-conducted city are provided with all possible safeguards. These consist, in the first place, of a projection room built in absolutely fireproof form with the most adequate ventilation through fireproof ducts to the outside; the provision of automatic shutters closing off the openings or ports leading into the house; equipping doors of projection room with self-closing devices; trained operators are required, and the wiring and connecting up of the machines is closely supervised. Further, a regular theatre is provided with fixed seats, generous aisle and exit accommodation, and in a well-conducted house the ushers are carefully drilled in their duties of looking after the safe exit of the audience in the event of fire or panic; in short, the public is supposedly as well protected as the authorities can possibly devise.

Now, it is a strange thing that once we get away from the confines of a properly-equipped theatre, there seems to be a disposition in many quarters to imagine that this highly-dangerous material can be handled with impunity by anyone in any place at any time, without its well-known attendant risks. Surely it is perfectly obvious that if the use of this product has been attended with such disastrous results in the past in theatres, Divine Providence is not going to safeguard, for instance, its use in a church wherein no attempt has been made to protect the audience. Such a thought is preposterous, and yet this is practically the position.

MANUFACTURERS' CLAIMS

I am perfectly aware that specious claims are made by manufacturers of so-called suitcase machines, miniature machines *and asbestos-lined* machines; that these can be used with *perfect safety with* regular full-width nitro-cellulose film *without the use of* a fireproof operating room and other safe-

guards. But be on your guard; such claims cannot be substantiated even though an incandescent lamp is used for illumination purposes, and I am firmly convinced that unless those officials who are supposed to control this situation wake up and exert their authority, we will have a succession of accidents of a most regrettable character. Two accidents of recent occurrence which are well authenticated are as follows:

The July, 1920, *Quarterly* of the National Fire Protection Association describes an accident in Seattle in May of that year, when the automatic shutter in a well-known suitcase type of machine, made up within a sheet metal cabinet, lined with asbestos, stuck, thereby exposing the stationary film to the rays of the lamp and caused the film to take fire. The minister of a church, who was displaying the film, picked up the machine and carried it with the blazing film and threw them outside the building. An incipient panic among the children started, but fortunately the teachers were able to control them and stopped the rush. Meanwhile, in other rooms of the school, the screams of the children and the smell of the burning film had reached other pupils, and a further panic was with difficulty averted.

DANGER OF STANDARD SPROCKETS

Another report furnished by the Bureau of Gas and Electricity of the City of New York relates a case which took place in October, 1921, in a large apartment house where a tenant brought into his apartment, to add to an entertainment he was giving, a portable machine of the suitcase type. Owing to the machine stopping, the film in the machine took fire, and the fire spread at once to the other films, completely gutting the apartment. In this case the machine was labelled "For use with slow-burning film only," but carried standard sprockets, which enabled it to use the regular theatrical film.

The *Quarterly* before mentioned also reports a fire in New Orleans, in May, 1920, in which a toy machine, known as the "Keystone Movigraph," and purchased by a boy of fourteen for $5, caused the ignition of a considerable amount of film of the regular nitro-cellulose type. The boy had picked out from the refuse of the various film exchanges enough scraps to build up about 10,000 feet of assorted film which was stored in the attic of the house and which he used to amuse his playmates. Fortunately a fire station was located across the street and this probably saved the house from total destruction, but we can well imagine that there might have been a serious loss of life had the boy been showing the film before a number of children at the time. This incident brings out the necessity *of preventing* the sale of toy machines that are so built that

they can utilize regular full width film. It also manifests the necessity for effectually dealing with the disposal of waste film exchanges.

What is the remedy for this position of affairs? I will first allude to some ineffective efforts of the past. One was that the so-called miniature or suitcase machine should be fitted with a special sprocket so that regular film could not be used in it, but which would allow of full-width slow-burning film to be used. This film to be furnished with special perforations to fit the special sprockets. This expedient has proven absolutely futile, as the user changed the special sprockets to standard type. Then there was the promising development of the narrow width machines such as the Pathescope and the Victor, and while these machines with the narrow-width slow-burning film have afforded some relief, it is not adequate. There are not sufficient stocks of film subjects printed on narrow width film available and while we have been promised for several years that large stocks of these would be put in circulation such have not materialized.

It seems to me, and I know I am not alone in this view, that we must in every way possible urge churches, educational and governmental bodies to call for the slow-burning cellulose acetate film, leaving it to the user as to whether full-width or narrow-width film is to be used. When we are certain that the film is of that type, we can safely relax all precautions. If parties will not demand such film and persist in using the dangerous nitro-cellulose variety, we must without doubt call for all possible safeguards.

In reference to the point as to how we are to determine the type of film, I offer a suggestion as follows: Why should not the various censor boards handle the problem in this way: Let these boards demand that *all* film, of whatever type or for whatever use, theatrical, religious, educational, be submitted to them before being exhibited by anyone. The travel films, religious and educational films so submitted need not be censored, but by simply examining the margin of the film they will find that all slow-burning film is so marked at regular intervals.

FILM WITH SPECIAL MARKING

If the film is so marked or otherwise identified, a perforated "leader" worded as follows: "Slow-Burning Film, Examined and Approved, Censor Board, Province of ——," should be attached to each reel by censor. He should stamp the film with a similar legend in from 8 to 10 places to the 1,000 feet.

There should be enacted a law or by-law making it com*pulsory to have* a permit before making use of a motion-*picture machine.* If the application covers a theatre or other

building fitted with a standard, permanent projection room, the applicant receives the usual yearly permit or license; but if it is an exhibition for one or two nights, the official would govern himself by the censor board's report on the film. If it is slow-burning the applicant is under no further restriction, and the permit can issue. If, however, the film is nitro-cellulose, and does not carry the special "leader" and stamp, the official should demand a fireproof projection room or fireproof booth, and give whatever directions he sees fit for the carrying out of the by-law.

These suggested regulations, which are intended to encourage the use of slow-burning film for non-theatrical purposes by the letting down of all bars once the character of the film is established, should not be accompanied by an obnoxious system of fees either on the part of the censor board or otherwise. Simply a small fee of, say, twenty-five cents per reel, unless the subject matter is such that calls for regular censoring on moral grounds.

SOURCES OF CO-OPERATION

We should also strive by every possible means to secure the support of the Dominion Government, the various Provincial governments and the railways, all of whom in their various activities circulate a considerable amount of film for one purpose and another. In this connection, I understand the C. P. R. are now supplying films printed on slow-burning stock for advertising purposes, also for lectures—the company has only recently supplied this form of film, as it was only accidentally learned by head officials that their publicity department was violating the company's own rules by transporting nitro-cellulose films for its own use in sleeping cars. The danger of such a practice is best illustrated by a film fire that occurred on November 24, 1914, in a passenger train running out of Chicago. A package containing only four reels of film that were being taken out for use in a suburban club became ignited about the middle of the smoking car four minutes after the train left the Chicago depot. Before the train could be stopped, thirty-eight passengers were badly burned, two fatally. While the United States Federal, and also Canadian, regulations call for such film to be transported only by express in yellow-labelled, approved type containers, it is difficult to prevent parties surreptitiously carrying this material as hand baggage.

The Dominion Government, Department of Trade and Commerce, also the Water Power and Forestry Departments, issue considerable film for publicity purposes. So far this has been supplied only on regular nitro-cellulose stock. Surely it is not too much to expect that the government should be will-

ing to assist us in this matter by its agreeing to supply slow burning film for other than regular theatres. In fact, I sug gest that we should memorialize the government to that effec The small extra cost of this safe type of film is now but three quarters of a cent a foot above the price of nitro-cellulose film so that there is no valid excuse that can be put up on th score, nor is there any difficulty developing or printing it. I is simply the lack of a compelling body of public opinio voiced by officials in charge of such matters that is hinderin the movement.

BROOM MANUFACTURING

Most Fires Result in Total Loss; Inflammable Nature of Material Used Contributes to Danger, Particularly in Small Establishments

Like numerous other industries, the manufacture of brooms does not always involve large establishments. Indeed, to the contrary, it often happens that the broom factory is located in a loft building housing other occupancies, or in a frame building of inferior type, so that the question of construction is one that should receive close investigation by the inspector. If the establishment is large, it is quite possible that buildings will be of substantial construction and this latter feature will form an important factor in determining the desirability of the plant as an insurance risk.

The manufacture of brooms involves no special construction features, but from the standpoint of fire protection the following general requirements are specified:

If located in a loft building along with other occupancies, the floor on which it is located should be cut off horizontally and vertically in a standard manner. Exposures through window openings should also be properly protected. In the case of frame construction there is no way to adequately safeguard these hazardous features. This is borne out by the adverse experience of many companies that have carried lines in this industry. Regardless of the type of construction, however, there is pronounced need of a dependable means for the extinguishment of fires in their incipiency. This need is best met by the automatic sprinkler. Where sprinklers are not installed, adequate standpipe protection, supplemented by a good supply of fire pails and chemical extinguishers of suitable type should be provided.

A broom is composed of two parts, namely, the blade or brush, and the wooden handle. The blade or brush is made of broom corn, a canelike grass cultivated in the United States; it resembles maize and has a spreading panicle of which the brooms are made.

BLEACHED OVER SULPHUR FIRE

When the broom corn or straw is received at the factory it is dipped in cold water to make it soft and pliable for working. It is then placed in a weak aniline dye solution to give it the usual greenish tint. When this dyeing operation has been completed it is placed in a bleaching chamber. The bleaching agents most commonly used are sulphur dioxide

and chlorine, but in many cases, especially in the smaller factories, bleaching is accomplished by means of sulphur which is usually burned in an open pan. This is probably the most severe hazard as the straw is hung in bundles above the burning sulphur.

The broom straw is then sorted by means of a machine which separates the straws according to size or length. This machine consists of a number of narrow belt conveyors of different lengths, running closely together and parallel to one another. The belts are studded with protruding pegs which catch the straw, separate it according to length, and carry it to the storage bins. A threshing, or seed stripping machine is used to remove the seeds. This machine consists of a cylinder thickly studded with flattened spikes. To remove the seeds the tasseled ends of the corn are pressed against the rapidly revolving cylinder. A device known as a "hurling machine" is used to cut the harl (filaments of fine fibre) from the stalk. This machine is usually power driven, but sometimes is operated by a foot pedal. A cutting knife cuts the harl from the stalk, the latter being taken up by toothed wheels and delivered into a storage bin.

Handles are usually dipped in a benzine or naphtha thinned paint, with the resultant attendant hazard.

The actual assembling of the broom is accomplished by hand with the aid of a squirrel-cage treadle and a clamping device to hold the broom handle. The workmen place the coarser straws around the handle, and by turning the treadle bind the straw with wire. The rough ends of the straw are trimmed off with a sharp knife.

ACCUMULATIONS OF REFUSE

This final trimming of the assembled broom and the various machine processes previously described, involve the dropping and accumulation upon the floor of large quantities of straw. In addition the machine operations create an excessive amount of chaff and dust, all of which are combustible and thereby introduce the hazard of dust explosions. Poor housekeeping, it would appear is a feature of this business. Daily sweeping of the factory is the exception rather than the rule.

There is a continual and very serious fire hazard in broom factories; due to the highly inflammable nature of the materials employed. This hazard is greatly increased in small establishments by the use of stoves for heating in winter.

Aside from its combustibility and attendant dust hazard, there is little danger in the storage of broom corn as it has never proven susceptible to spontaneous igition. It is, however, *very susceptible* to water damage and most fires usually result *in total loss due to* fire or water.

In order to safeguard the foregoing hazards to a reasonable degree the following conditions should be required:

Storage of broom corn and wooden handles should be separated in a standard manner from process rooms or buildings.

The rooms where trimming and seed-stripping are carried on should be cleaned at the close of each day. This waste material should not be permitted to accumulate in large quantities on the floor, but should be periodically collected during the day and either immediately removed from the building, or deposited in metal lined bins equipped with metal lined self-closing covers, to be emptied daily. If the plant is large, the advisability of an approved type of dust collecting system should be considered. Much of the dust created can be eliminated by means of an exhaust installed at the seed-stripping machine.

Bleaching process should preferably be carried on in a separate building; if otherwise, this process should be carried on in a separate room used for no other purpose, and cut off horizontally and vertically in a standard manner from all other rooms and floors. Provision should also be made to prevent the straw being bleached from coming in contact with the burning sulphur, if this method of bleaching is used. Preferably, a specially constructed bleaching chamber should be used.

Broom handle dipping is best safeguarded by housing the process in a separate, properly cut off room, or small building. This room should be well ventilated so as to insure rapid dissipation of inflammable vapors. Storage of dipping solutions should be in accordance with the requirements of the National Board of Fire Underwriters for the installation of containers for hazardous liquids.

WATER JAPANNING

Manufacturing Process Rated by Underwriters' Laboratories as Zero to Ten—Method Developed by General Electric Company Clean and Safe

There is claimed to be no fire nor explosion risk in the use of the water japanning process practiced by the General Electric Company. The basis of this claim is that the japan is an emulsion of a high oil japan base in water, there being no inflammable solvent present. The japan is generally shipped at a concentration of 30 per cent. base with 70 per cent. water and for most purposes is used at a concentration of 20 per cent. base and 80 per cent. water. A representative of the General Electric Company in Schenectady said to THE WEEKLY UNDERWRITER:

"Underwriters' Laboratories has rated water japan as zero to 10, compared with kerosene, 30 to 40 and gasolene 90 to 100. We presume that the ordinary japan with the inflammable solvent such as gasolene is rated in about the same class with gasolene, as the japan is composed to a large extent of solvent.

"With water japan standing in open dipping tanks, there is little or no evaporation loss and no fire hazard, as the japan is non-inflammable and there is no evaporation of inflammable solvent as in the case of the ordinary japan. After dipping in the water japan, the parts drip for only a few seconds, probably 10 to 20, and again there is no fire risk in the operation as there is no evaporation of inflammable solvent as in the case of ordinary japan. The parts are then placed in the oven for baking in the ordinary manner, but there is no secondary drip in the case of parts coated with water japan and therefore, there is no accumulation of japan on the bottom of the oven which contains inflammable solvent as is the case with ordinary japan.

"When water japan is baked, there is no inflammable solvent driven off and therefore, very little oven ventilation is required, all that is necessary being a small amount to carry off the little water vapor which is given off in the baking process.

"In the case of the ordinary japan, there must be forced oven ventilation on account of the large explosion and fire risks due to the inflammable solvent which is given off in

the baking and which must be carried off to keep the mixture in the oven below the explosion point.

"After baking, the water japan is insoluble in water and is equal in every respect to the results obtained by the best grades of ordinary japan and if anything adheres more strongly to the metal. While it is necessary to preheat the metal parts before dipping them in water japan, the cost of pre-heating is offset by the saving in evaporation losses and ventilation, and therefore, the cost of treating with the water japan process is no greater than that of the ordinary process. The water japan may be said to change the baking japan process from a dirty, dangerous process to a clean, safe one.

"While the cost of the two processes are about equal, the cost of water japan is considerably less than that of an equally good grade of ordinary japan and therefore, where considerable amount of japan is used, beside the elimination of all fire risk, there would be a considerable saving due to the difference in the cost of the japan.

DESCRIPTION OF PROCESS

In the *General Electric Review* water japan is the subject of an extended illustrated article by Wheeler P. Davey and P. Dunning, from which the following material is taken:

Baking japan, as it is ordinarily used in industry, consists of a "base" and a "solvent." The base contains one or more of the various asphalts, together with one or more siccative oils such as linseed oil or china-wood oil. The finished base is a tough rubbery mass which looks much like tar. It is the office of the solvent to dilute this base to a liquid, so that the metal may be easily coated with the desired amount of japan base. The solvents in common use are naphtha, kerosene, and similar products. The use of such solvents entails a considerable fire risk, especially in the oven in which the japanned metal is baked. It was to eliminate this fire risk that "water japan" was developed.

Water japan consists of an emulsion of japan base in water. By this is meant that an enormous number of tiny ultra-microscopic globules of japan base float around in the water japan in much the same way that globules of butter fat swim around in ordinary sweet cream. The diameter of the globules is about 0.00001 inch. The emulsion is permanent, showing no tendency to settle out even after several months. It may be strained in the same manner as ordinary japan and, if desired, may be cleaned in a commercial clarifier of proper design. Since water is the "solvent," the losses due to evaporation are negligible, especially if the japan is kept cool. Scum will *not form on the* surface if the temperature of the liquid is

kept below 100 deg. F. (38 deg. C.). After the water japan is baked, it is quite insoluble in water. The range of concentration which may be successfully used is very great, so that little supervision is required.

The viscosity of water japan is much less than that of the same base dissolved in kerosene or similar solvents. There is a possibility that, in the future, methods may be worked out by which the viscosity of water japan will be so adjusted that metal may be coated with water japan by dipping in the same way as with ordinary japan. However, the advantages of employing certain entirely different methods of applying the japan base to metal before baking seemed great enough to justify their development. They all have this feature in common—the japan base is deposited on the metal in a solvent-free condition. In this way, the behavior of the japan in the baking oven depends entirely on the characteristics of the japan base employed so that "secondary drip" is rendered negligible. These methods of applying water japan are given in detail below.

THE ELECTRIC-DIP

The electric-dip method is adapted to small odd jobs of japanning rather than to quantity production. The water japan is put in an iron tank which is connected to the negative terminal of a direct-current circuit. The metal to be coated is connected to the positive terminal of the circuit. Since the globules of base in the water japan carry negative charges the base will be attracted to the positively charged metal. The water is left behind, so that the metal is covered with a thin film of japan base, free from solvent. This film possesses some insulating properties even before baking, so that, as soon as the most exposed portions of the metal are coated, deposition starts in whatever holes and recesses may still be bare. The thickness of the deposit of base depends upon the product of the current-density and the time. Using a 125-volt circuit, the time required for a satisfactory coat is about 2½ seconds. In using the electric-dip method no special voltage is necessary. The work is connected directly across a direct-current line of high current carrying capacity without series resistance, so that the current flowing will be proportional to the area to be covered. The current on 125 volts will average about 0.8 ampere per square inch of surface to be covered. Due to the polarization effect, the current is higher at the instant the circuit is closed than at the moment of breaking. Time is most conveniently measured by means of a time switch connected to a relay. Accidental short circuits are prevented by a wooden grating on the sides and bottom of the tank. It is absolutely necessary that the

surfaces of the metal to be coated be free from grease or other insulating material. During the time the japan base is being deposited, the metal should be submerged at least two inches below the surface of the water japan so as to allow it to be in approximately uniform electric field. Only one coat can be given by the electric-dip process as baked water japan acts as an insulator.

THE HOT-DIP

The hot-dip method is adapted to work with large quantities of small castings, punchings, etc., where it is essential that the labor cost be kept at a minimum. The metal to be japanned is placed in wire baskets and heated in an oven to a temperature of about 500 deg. F. (260 deg. C.). It is then cooled to about 400 deg. F. (200 deg. C.) and quickly plunged into the cold water japan. The japan base leaves the water and collects in a film on the surface of the metal. After the basket has remained in the water japan about ten seconds it is removed, drained for about 30 seconds, and placed in the baking oven, where it is baked in the usual manner. After baking, the basket is emptied into storage boxes. The baskets may be handled entirely by chain-falls or an air-hoist, so that upwards of 100 lbs. of metal can be handled at once. Except when the pieces of metal to be coated are very small, reinforced baskets of ½-in. mesh wire screen are suitable. The metal is often shoveled directly into these baskets, especially if it is in the form of small irregular castings or punchings. In some cases, however, it is advantageous to pack the contents of the baskets systematically, either for the sake of getting in a greater number of large pieces or of determining where the points of contact from piece to piece shall be. There is no handling of the individual pieces from the time the basket is filled until it is finally emptied into the storage box. Pre-heating was originally developed as a cheap method of cleaning grease and oil from metal before japanning. It is especially useful on steel punchings, and on brass, copper and aluminum. Most grease of this sort is thoroughly cleaned off if the metal is heated to a temperature of 500 deg. F. (260 deg. C.) and kept there for a half hour. It was soon found that if this pre-heated metal was quickly plunged into water japan while still hot (250 to 400 deg. F.) that the heat in the metal had the same effect as the electricity in the electric-dip process in causing the japan base to adhere to the metal leaving the water behind. There was this additional advantage, that the surface of japan base immediately in contact with the metal started to bake from the residual heat of the metal, thus tending to insure good adhesion.

In case the metal to be coated has flat faces, there is a

chance that two flat faces may lie together so that neither of them would get a satisfactory coat. This may easily be obviated by dumping the hot contents of the basket into the water japan, catching the metal in another basket below.

Due to the fact that there is practically no "secondary drip" with water japan the scars due to the contact of one piece with the edge of another in the basket are negligible. After baking, the baskets are usually emptied by turning them upside down. In case it is desired to give more than one coat of japan, the basket is taken out hot from the baking oven and at once dipped. It is then put back to be rebaked.

CONCLUSION

In using ordinary japan, the thickness of coat depends upon the viscosity of the japan. This is measured in terms of its density as shown by a hydrometer. In none of the foregoing methods described for using water japan has the viscosity been an important factor. Instead, the emphasis is placed upon the concentration of japan base in the liquid. Even here, the limits are quite wide for the maximum permissible concentration is about twice the minimum. For convenience, a concentration meter has been designed by which the concentration may be easily measured directly. The base is coagulated from a known amount of water japan by a solution of $FeCl_3$, $CaCl_2$, or a mixture of them. The lump of base is freed from water inclusions and is then weighed. This apparatus is very compact and requires as little supervision as the water japan itself.

FINISHING AND FOAM HAZARDS

Results of Many Years' Work by Manufacturing and Special Hazards Committee of National Fire Protection Association

During October, in Detroit, there was held one of the most interesting and important committee meetings in the history of the National Fire Protection Association work. This was the meeting of the Committee on Manufacturing Risks and Special Hazards, where the final editing was completed of this committee's rules covering Dip Tanks, Spray Booths, Japanning and Enameling, Flow Coat Work, Hardening and Tempering Tanks and Foam Extinguishing Systems. Benjamin Richards, chief engineer of the Western Factory Insurance Association, is chairman of this committee. Although there are representatives on this committee from the Pacific Coast to the Atlantic and down to the Gulf, only three members of the committee were absent.

One whole evening was devoted to talks by the manufacturers of these devices who gave the committee the benefit of their wide experience. These manufacturers were also invited to sit in at the meeting and offer suggestions as the several points of discussion came up. Representatives of the manufacturers of foam-producing liquids and foam-extinguishing devices were also present and from the beginning freely offered for the use of the committee all the necessary data relating to this important subject.

A full half day was given to a tour of some of the large plants in Detroit where the actual conduct of the industrial work covered by these rules were observed. This tour was very instructive to the members and together with the explanation of the processes given in the manufacturers' talks gave a clear understanding of the problems involved. The committee is indebted to George W. Cleveland of the Michigan Inspection Bureau for this and other entertainment.

HAZARDS HAVE CHANGED GREATLY

These rules replace the old National Standard for Dip Tanks, the revision of which was referred to the committee about five years ago. In attempting to revise the old dip tank rules the committee found the subject very much involved and the growth of the hazards in the industries, particularly the automobile industry, necessitated much pioneering work on the part of the committee to the end that the hazards should be safeguarded and co-operation with manu-

facturers of the devices established. The changes in these hazards have been so marked and rapid that the committee necessarily was obliged to delay the final completion of its work until the arts had more or less settled down and actual fire experience could be obtained. To this end various schemes of protection were installed, some of them so long as three years ago, with the result that the committee is able to present as its finished rules standards which it is safe to assume, if followed out, will put these severe hazards under control. In some automobile factories finishing rooms may contain 20,000 to 30,000 gallons of naphtha dip exposed to fire, presenting a problem in fire protection heretofore unheard of.

ENAMELING OVENS

During the committee's work there occurred also several explosions of enameling ovens which necessitated a thorough study of the ventilation and hazards of these ovens. Not only the thousands of small box type ovens were given consideration but the rules are also made adequate to cover large continuous conveyor ovens fifty to one hundred and fifty feet long, now often found.

COMPRESSED AIR PAINTING

The process of painting and lacquering by compressed air, involving the use of spray booths, has also come in vogue largely since the committee undertook this work. The spray booth fire record and hazards were carefully reviewed and co-operation established with the manufacturers with the result that definite rules for safety have been made. The co-operation of Underwriters' Laboratories with the work of the committee will, it is hoped, result in many devices covered by the rules being placed under Laboratories' service, to the end that further safety may be brought about.

FOAM FIRE EXTINGUISHERS

The recent development of foam as an extinguishing agent for inflammable liquid naturally brought this subject under the consideration of the committee as protection in a special form is absolutely necessitated by these new and severe hazards. While foam had long been used for the protection of large oil tanks in the oil fields, its application automatically to special hazards in industrial risks is new and largely through the offices of this committee apparatus for this protection has been developed.

The committee is particularly indebted to A. O. Boniface of the Foamite-Childs Corporation for his continual co-operation and for his instructive exhibit of motion picture films showing the use of foam on oil fires.

The subject of the committee's work has been placed in a

tentative way before three N. F. P. A. conventions and at the last convention the rules were adopted subject to slight revisions covering points referred back to the committee. The executive committee was given authority to recommend the publication of the rules when these few points were given consideration. It is expected that these rules will soon be in print for general distribution.

WHAT RULES COVER

Section A of the new rules covers dip tanks, with specific advices and rules covering the general conduct of the dipping process and classification of the tanks, Class A covering large tanks exceeding 25 square feet in area, Class B medium tanks 10 to 25 square feet in area, Class C small tanks up to 10 square feet in area and Class D covering tanks containing inflammables which do not flash at less than 100° F. Detailed specifications covering automatic drains and overflow pipes, automatic foam-extinguishing protection, arrangement of water sprinklers with hoods and curtains to prevent overflowing and portable dip tanks, are all included in the rules.

Section B covers hardening and tempering. This is a small section covering some fundamentals of safety, this process not being at present sufficiently standardized to warrant detailed rules.

Section C covers flow coat work, which is the application of paint and varnish by means of a hose and nozzle as contrasted with spraying and brush work. This section is also brief, covering some general items of safety.

Section D covers paint spraying and spray booths and includes detailed suggestions and specifications for the general arrangement of the process, the ventilating or exhaust systems and the installation and construction of booths.

Section E covers japanning and enameling, including the ovens necessary for this work. Detailed rules covering the general conduct of the work, construction and arrangement of ovens and their protection are given.

Section F covers foam-extinguisher systems applicable to the previous sections. The introductory covers the general uses and application of foam as common to all systems. This chapter is subdivided into Sections A, B and C.

Class A covers systems for outdoor hazards such as large oil farms and storage of oil in large tanks in factory yards. The rules laid down in this section are broad and cover fundamentals, leaving to the inspection departments having local jurisdiction and to the rating bodies the details which may be called for by the particular conditions in the various fields.

Class B covers the use of foam throughout rooms or buildings such as might be protected by a sprinkler system de-

signed to deliver foam over the general area and this section gives detailed rules for the capacity, means of supply, automatic control and pipe systems.

Class C covers the local hazard such as is found in many industrial plants where the application of foam is supplementary to the general protection of the property and is to cover only a limited area or a particular spot such as one or more dip tanks. Detailed specifications as to the arrangement, automatic release devices, pipe sizes and capacities are given.

The committee is to be congratulated on the completion of this work. General enforcement of these rules by the various jurisdictions will result without doubt in a marked reduction of the fire losses.

SISAL TESTS

Underwriters Laboratories Declares That Practically No Expansion Takes Place When Bales are Wetted. Impracticable to Dry this Product after Wetting

Underwriters Laboratories, Chicago, has completed an elaborate report on an investigation of the fire hazard in sisal, which is presented by A. H. Nuckolls, chemical engineer of laboratories. The numerous tests were made by C. J. Krieger, general assistant chemical engineer; A. E. Maitre, assistant chemical engineer; A. F. assistant chemist; C. A. Tibbals, special assistant chemist. Introducing this subject the report states: Large quantities of sisal are imported annually to the United States, principally through the port of New Orleans. Stocks of very large value are stored not only in New Orleans but in other gulf ports and in the interior, particularly Chicago and Indianapolis. It is reported that the approximate value of sisal stocks in the latter city alone has amounted to over $5,000,000. Such a large stock comprises the contents of various warehouses. About 40,000 bales is the maximum amount known to be subject to a conflagration.

Conclusions reached by the investigators follow:

Combustibility of Sisal. Sisal whether loose or baled presents a considerable fire hazard when exposed to sparks or flame, such as red hot cinders, lighted cigarettes, flash fire from sparks and flames from matches.

Ignition by Heat. The apparent ignition temperature is about 325°C. (617°F.). When the product is heated fairly rapidly to this temperature ignition results. When heated at 100°C. (212°F.) for 96 hours no charring occurs. At 130°C. (266°F.) the fibres are charred. Prolonged heating at 266°F. or above would probably result in ignition. The results of the Heat Ignition tests indicate that while the fibres are damaged by long heating at 60°C. (140°F.) a higher temperature is required to produce ignition.

Ignition by Sparks and Flame. The product is easily ignited by contact with ordinary sparks such as are discharged by coal burning locomotives or lighted cigarettes. Ignition readily occurs by contact with a small flame such as produced by an ignited match.

Combustion. When ignited by contact with flame sisal burns rapidly, the flame spreading very fast and producing a hot fire. Local flash fires occur on ignition by a flame, but the area covered by the flash period is not large. The flash is produced by projecting ends of fibres, the number of which at any given *place on the bale* varies. Ignition from contact with live sparks

may result in the immediate production of flame or a smoldering fire which is likely to burst into flame sooner or later according to conditions. A smoldering fire may burrow to a considerable extent.

The flaming combustion of a bale is more intense during the period when the exposed surface is burning following which a smoldering and burrowing combustion predominates. The results of the tests indicate that a fire will progress less rapidly in a stock of bales having a minimum amount of exposed surface.

Spontaneous Heating of Sisal. Sisal when wet heats spontaneously.

Fermentation and Decomposition. The results of the tests indicate that the process of spontaneous heating of sisal is primarily one of fermentation, carbon dioxide and ethyl alcohol being among the products formed.

Temperature Developed. The tests show that a temperature of 60°C. (140°F.) may occur within the bale.

Oxidation. The results of tests with specimens and matter extracted by acetone indicate that sisal is not easily oxidized at temperatures in the neighborhood of 60°C. (140°F.).

Rate and Duration of Spontaneous Heating. The test results show that spontaneous heating develops in about 40 hours after wetting the bale, and produces a rapid rise in temperature of about 30 to 35°C. (54 to 63°F.) during the succeeding 40 to 50 hours.

SPONTANEOUS IGNITION OF SISAL

Baled sisal is not liable to spontaneous ignition under ordinary storage conditions.

The above conclusion refers to cured sisal known as henequen, which is principally grown in Mexico and is the sisal of commerce in this country. The fire hazard of any related hard fibres of this family met with commercially under the name of sisal is probably in the same class.

The susceptibility of the fibres to spontaneous heating when in a loose state unless in large piles probably would be similar to that of bales.

Test data are not available relative to the tendency, if any, of the uncured fibres to ignite spontaneously, but it is judged that their behavior in this respect would be in general similar to that of the cured fibres; possibly the uncured product is somewhat more susceptible to spontaneous heating. Reliable information regarding the curing process indicates that the fibres are easily cured, and that the possibility of bales reaching this country in the green condition is very remote.

The addition of oil to sisal increases its inflammability and *may render it liable* to spontaneous ignition, depending upon the *nature of the oil.*

Conditions Under Which Spontaneous Heating Occurs and Factors Influencing It. The results of the spontaneous heating tests with specimens and bales together with the temperature measurements made in warehouses show that the dry sisal containing a normal moisture content, 10 per cent. by weight of water, is not subject to spontaneous heating. These tests included new and old sisal when under both laboratory test conditions and practical storage conditions.

SUBJECT TO SPONTANEOUS HEATING

The results of the tests with bales show that when wet sisal has a tendency to heat spontaneously but the temperature developed is below that required to obtain ignition. (See heat ignition tests.) The temperature developed by spontaneous heating in the tests with bales was determined under various conditions, including the factors of major importance which are known to influence the process of the spontaneous heating, and also factors which it was though might have a bearing on the results. The varying test conditions and factors referred to include: the moisture content of the bales, and the presence of carbon dioxide, a product of fermentation.

Test variations in the moisture content included bales containing 10, 20, 30, 35 and 40 per cent. by weight of water, using both rain and distilled water. The results show that maximum heating of bales occurs within this range.

The tests included surrounding temperatures of about 25°C. (77°F.) and 35°C. (95°F.). The external temperatures at the surface of the bales spontaneous heating was higher than the surrounding walls of the box. By raising the exterior temperature the loss of heat produced by spontaneous heating within the bale is reduced. The object of reducing the loss of heat was to obtain a test condition similar to a heating bale when surrounded by adjoining bales, as may occur under actual storage conditions. The results of tests, using preheated air as in Spontaneous Heating test No. 2, Bale No. 1, indicate that the surrounding temperature range employed was sufficiently high for the purpose sought. See Fig. 7 in connection with the data recorded in the results of the Spontaneous Heating Tests with Bales.

Tests are included in which the air supply or ventilation of the bales was varied during the period of spontaneous heating.

PRESSURE UNDER STORAGE

The pressure to which a bale is subjected under storage conditions varies, and a test was included to obtain data on the effect, if any, of increasing the pressure on the bale during its period of spontaneous heating. As the result of this test indicated that the pressure employed did not appreciably accelerate

the heating of the sisal or augment the temperature, no additional pressure tests were deemed necessary.

Prolonged decomposition tests, extending over a period of years, are not included.

Examination of the fibres following the spontaneous heating tests and additional heating yielded no data indicative of any tendency of the sisal to undergo active oxidation and ignite spontaneously.

Damage by Water. It appears that practically no expansion occurs on wetting the bales. It is impracticable to dry the product.

Storage Conditions. It appears from a study of the test data that in the storage of sisal precautions should be taken to:

(1) Exclude any of the product which is wet.
(2) Store in warehouses protected from the weather and exposure to sparks and flame.
(3) Preferably exclude other products.
preferable.
(4) Avoid exposing a larger bale surface to the air than is consistent with safe practice in allowing aisle space for work of extinguishing fire and removing bales. Numerous sub-divisions of storage space by partitions is preferable.

CHEMICALS IN WAREHOUSES

Effect of Individually Harmless Combinations When Exposed to Heat or Water; Ventilation

To the laymen, the term "chemical" is usually associated with some mysterious substance capable of creating conditions favorable to fire and endangering life, either through the generation of fumes, or by possible explosion. One need not investigate very far, however, before discovering that this general hazard is not common to all chemicals and that the majority are as harmless as most of the materials used in every-day commerce or manufacture. It remains then to differentiate between the hazardous and non-hazardous chemicals. To my knowledge there has never been prepared a book containing this information and indicating the individual hazards and general precautions as to storage and fire-fighting methods, readily understandable by the non-technical mind.

The rapid development of the chemical industry in this country, the use of chemicals in manufacture and the curtailment of waste through the recovery of by-products creates a pronounced demand for such information. It is only natural that a fire department officer should hesitate to send his men into a room or cellar where chemicals of unknown hazard are stored, hence if there is no hazard involved, this excusable lack of knowledge may be the cause of fires, the extent of which would otherwise be insignificant. We cannot expect the officers of our fire departments to be chemists, but if we place in their hands regulations so stripped of unnecessary technical terms that they cannot help understand them, we shall have taken a big step in the right direction.

The Committee on Fire Prevention and Engineering Standards of the National Board has been considering this subject for some time and preparing a set of regulations and these regulations are but in the making, and after the tentative draft has been completed they will undoubtedly be extensively revised by a committee of the National Fire Protection Association before final adoption by the National Board. This ambitious undertaking involves a great deal of research and other labor, as it frequently happens that authorities differ among themselves and the novice must read all contentions before he endeavors to take sides. Again, it quite frequently happens that chemicals, in themselves harmless, become hazardous when in contact with others, and, of course,

when considering storage requirements this feature must be considered. In planning these regulations it was decided to classify the various chemicals according to their structure, hence the tables are arranged as follows:

Class I. Liquids.
Class II. Semi-solids or pastes.
Class III. Solids.

IN FORM OF ORDINANCE

The making of the various lists of chemicals so comprehensive as to include all those of a hazardous nature was a difficult matter, and indeed these lists may be considerably added to before the work is completed. It was also decided to arrange these regulations in the form of an ordinance to so enlarge on the nature of hazards and precautions for storage as to make it a regulation and a textbook for the enforcing officials at the same time. Any such ordinance or regulations omitting that phase relating to the life hazard fails to adequately cover the subject. Indeed it is this feature that very largely determines the procedure of the fire department under fire conditions. It will be noted that one column in the tables is devoted to a description of the life hazard. The tabular system has been adopted as it enables one, at a glance, to acquaint himself with all the information necessary; it also avoids the use of extensive description data, that would only tend to confuse the reader.

It will, of course, be necessary to employ the use of certain technical terms and for that purpose a chapter on definitions will be included, so that the reader will not be handicapped by a lack of understanding as to the meaning of such terms.

LIBERATION OF OXYGEN

Another chapter will deal with carriers of oxygen, i. e., those chemical including oxygen in their composition. This element, is, so to speak, the life of fire; in fact fire is simply the oxyidation of substances. It is apparent then that all substances which readily part with oxygen upon the application of heat or water should be isolated from materials that are readily flammable. The most important carriers of oxygen, so far as our purpose is concerned and the temperatures and conditions at which they liberate oxygen are, as given by Von Swartz, as follows:

The peroxides liberate oxygen from 572° F. to 1,832° F.

Potassium peroxide and sodium peroxide, at white heat, when dissolving in water, and also gradually when gently warmed.

Perchloric acid, at the slightest opportunity, even during *storage, with violent* explosion.

Permanganic acid, on gentle warming, any organic matter present being thereby ignited.

Potassium perchlorate at 752° F.

Potassium permanganate, in a warmed solution; dry, at 464° F.

Iodic and periodic acid at 572° F.; at ordinary temperature in presence of organic matter.

Persulphuric acid, same as peroxides.

Potassium or ammonium persulphate at 212° F.; at ordinary temperature when dissolved in water.

Potassium perselenate liberates oxygen when the solution is warmed.

Chloric acid liberates oxygen at ordinary temperatures and on contact ignites organic materials.

Chronic anhydride at 482° F.; detonates and ignites organic substances when immersed in alcohol.

Chlorates liberate oxygen in an explosive manner under the influence of friction, shock, concussion, or heat (752° F.). When mixed with potassium cyanide, oxygen is immediately disengaged with explosion.

Nitrates, at high temperatures (932° F. to 1,112° F.).

Nitrogen pentoxide with violence, at 122° F.

Nitrous oxide and nitric oxide, at 932° F.

Sulphur heptoxide violently when dissolved in water or warmed.

Bismuth heptoxide when heated or treated with strong acids.

Calcium hypochlorite (chloride of lime) when gently warmed or exposed to direct sunlight.

The extinguishment of chemical fires is a problem in itself and the difficulties of a fire chief in this respect are readily realized. During the war an officer of the Construction Division made plans of a proposed toxic gas plant. He asked a fire engineer to specify and design the fire protection system and furnish him with an estimate of cost. Investigation disclosed that the gas to be manufactured was spontaneously inflammable upon contact with air or water, at the same time liberating deadly fumes.

VENTILATION NECESSARY

In some fires the employment of water may be very dangerous. These cases are rare, however, the principal exception being calcium carbide, which generates acetylene upon contact with water. But it is important that caution be exercised *in fighting* chemical fires. Upon rolling up to a fire where

there is reason for belief that chemicals are stored or used, an effort should be made to locate them, and in making such an investigation a gas mask should be worn. If it is found that the chemical storage is involved, the room or compartment should be ventilated. Ventilation is of prime importance for the reason that chemicals give off gases that are noxious (dangerous to life), or combustible, in which case the hazard of explosion is treated. If the fire is small then the hand appliances provided should be used; in this connection the fire department or fire prevention bureau should see to it that manufacturers or others provide private protection equipment suitable for combatting the particular hazard involved. Where a fire has made such headway as to preclude extinguishment by hand appliances, then the only thing to do is to flood it with water. Large tips and low pressures should be used to insure proper flooding effect. Small tips and high pressure will only serve to cause further breakage of containers and consequent liberation of additional fumes or vapors. It is pointed out that acid carboys are made of glass, hence their susceptibility to breakage is apparent. For small fires sand is probably the best.

Chief Thomas Clancey, of the Milwaukee fire department, in a paper on nitric acid fires, says: "Never throw saw-dust on nitric acid, as this greatly increases the volume of the deadly gases and does no good. Never allow a chemical engine to be used, and never throw soda on the acid, as these generate carbonic acid, which is a heavy gas and makes a blanket over the deadly gases, thus confining them, as a rule, to the room."

Chief Clancey knows whereof he speaks, as during the time he was assistant chief nitric acid caused the death of Chief James Foley and three other members of the department. In telling of this case Chief Clancey says in his paper:

"An instance of fatal effects resulting from inhaling fumes of nitric acid occurred in Milwaukee February 3, 1903. On the afternoon of that day the department was called to a supposed fire in a four-story mercantile block used for the manufacture of rubber stamps, seals, dies, etc. The writer, who filled the position of assistant chief at that time, was one of the first to arrive and found what resembled smoke issuing from the third and fourth floor windows. On entering the building we found that one of the employees had carelessly dropped a carboy of nitric acid from a truck on the third floor, spilling its contents. Other employees had immediately *thrown saw dust* on the acid, obtained from a barrel nearby, *which generated* a dangerous gas. Members of the depart-

ment swept up and removed the sawdust from the building and opened the windows and scuttles to ventilate same, and were not occupied with this work more than fifteen or twenty minutes.

"Outside of a tickling sensation in the throat and nose, we experienced no ill effects at the time. Later in the evening, however, between fifteen and twenty members of the department were seized with violent congestion of the throat and lungs, while on duty in the various engine houses. A number of prominent physicians were called, but were apparently helpless to give any relief to those affected. Before the following morning four members of the department, including Chief James Foley, had passed away, while several others were in an unconscious condition for a number of days and were off duty from the effect for over three months.

"About this time several members of the medical profession published articles in the daily papers showing what would finally result to those who inhaled the fumes, stating that none of those affected would ever recover, as they would pass away in a short time from tuberculosis and other pulmonary troubles.

"These articles evidently preyed upon the minds of the men affected and no doubt interferred considerably with their speedy recovery. In fact one member was so influenced that he took his own life by cutting his throat, a month after the occurrence. However, I can say that their theories proved untrue, as not one of those affected died from the effects. In this connection I might say that the members of the department were not aware of the nature of the material we were handling at the time, or we would have exercised more care in ventilating the building and disposing of the acid."

Chief Clancey's concluding statement emphasizes what was previously brought out, the importance of ascertaining the nature of the chemicals and the importance of ventilation.

For the benefit of anyone skeptical as to the value of water on such fires, the following sprinkler report is cited, taken from the April *Quarterly* of the National Fire Protection Association. These figures cover a 24-year period ended February 1, 1921:

Drug Houses: Total number of fires, 187; number of fires extinguished, 149, or 79.7 per cent.; number of fires held in check, 34, or 18.2 per cent.; total satisfactory, 183, or 97.9 per cent.; unsatisfactory, 4, or 2.1 per cent.

Dry Cleaning Establishments: Total number of fires, 8,

number of fires extinguished, 6, or 75 per cent.; number of fires held in check 2, or 25 per cent.; unsatisfactory, none.

Linseed Oil Works: Total number of fires, 25; number of fires extinguished, 14, or 56 per cent.; number held in check, 10, or 40 per cent.; total satisfactory, 24, or 96 per cent.; number unsatisfactory, 1, or 4 per cent.

Oil Refineries: Total number of fires, 16; number of fires extinguished, 7 or 43.8 per cent.; held in check, 8, or 50 per cent.; satisfactory, 15, or 93.8 per cent.; unsatisfactory, 1, or 6.2 per cent.

Paint and Color Works: Total number of fires, 203; number extinguished, 142, or 70 per cent.; number held in check, 55, or 27.1 per cent.; total satisfactory, 197, or 96.7 per cent.; unsatisfactory, 6, or 2.9 per cent.

Chemical and White Lead: Total number of fires, 131; number extinguished, 75 or 57.3 per cent.; held in check, 46, or 35.1 per cent.; total satisfactory, 121, or 92.4 per cent.; unsatisfactory, 10, or 7.6 per cent.

Of course the details of these fires are not given, but the record in general indicates that the cooling effect of large quantities of water at low pressure is very material in fires of this nature.

For oil fires, sand, or sawdust and soda, and foam solutions, either by hand containers or through sprinkler systems, form the best means of extinguishment.

In connection with the use of extinguishers of the carbon tetra chloride type, care should be exercised that these extinguishers are not used in poorly ventilated compartments or rooms. Experiments by the Bureau of Mines and Underwriters' Laboratories have indicated that carbon tetra chloride gives off phosgive, chlorine and hydrogen chloride, all of which are poisonous if inhaled in sufficient quantities. This caution is given as there is a tendency to use these extinguishers in laboratories and elsewhere where chemicals are used or stored.

It has been suggested that an ordinance of the kind herein outlined should be administered by the fire prevention bureau. Chemicals should be stored under permits obtained from and after thorough investigation by such a bureau. Chemicals not listed as hazardous and of unknown properties should be classified by the bureau's chemist or, when chemist is not included in the bureau's personnel, by the bureau of explosions of the American Railway Association. As a suggestion, each fire company would be supplied with a set of cards alphabetically indexed, each card would be devoted to description data as to hazards of individual dangerous chemicals. The

companies would also have copies of the bureau's inspections of manufacturing plants and other occupancies using or storing dangerous chemicals. With some such scheme, the fire department could keep posted as to the location and nature of hazards of chemical occupancies.

METALS CAPABLE OF CAUSING MANY FIRES

Light Metals Possess Greater Explosion and Fire Hazard; Combination With Water Often Produces Destructive Gas; How Various Metals Are Affected.

To the layman the title of this article appears absurd. The hazard of metals indeed, how can metals possibly be dangerous, is the natural question. Yet the assertion implied by the title, is a truth, for under favorable conditions, some metals are as dangerous and exhibit as great violence as the most powerful explosives known. As a matter of fact metals to some extent are used in the manufacture of certain explosive powders; illustrations being aluminum powder used in star shells for night time ordinance questions, and tracer bullets, also powdered magnesium for photographic flashlight purposes. So let us accept the title as a fact, and investigate further into these phonomena.

Of the two chief classes into which metals are divided, light and heavy metals, the former generally exhibits the greater fire or explosion hazard. This does not imply that heavy metals are free from serious danger; to the contrary, under certain conditions the heavy metals often involve great danger. In general, metals are dangerous when they meet any of the following conditions:

a. When they are themselves combustible.

b. When in a finely divided form—powdered.

c. When capable of decomposing water into its component gases, oxygen and hydrogen, at ordinary temperatures or at red heat.

d. When they dissolve in dilute acids and liberate hydrogen.

In compact masses aluminum is perfectly harmless, but it is readily ignited when drawn out as fine wire, or in small flakes, and is explosive when pulverized. Any flame will ignite aluminum dust. In the compact state this metal does not decompose water, but it will do so when in powdered form, or when mixed with caustic potash or soda. Uranium in powdered form ignites at 518 degrees Fahrenheit. Iron in powdered form will ignite spontaneously when freshly prepared. Zinc in the form of powder takes fire when heated to 680 degrees Fahrenheit. Cadmium, Molybdenum, Antimony, Indium and Tungston are combustible when highly heated, and when in the form of fine powder. Cobalt is combustible when raised to a white heat, or spontaneously so when in a finely powdered form.

Let us now consider another feature that contributes the greater part of the danger of metals. Water consists of two elements, namely, oxygen and hydrogen in a state of chemical combination. When these two elements are merely mixed together, however, they form a highly explosive gas, or in other words, oxydrogen. Although it supports and fosters combustion and is indeed the very life of fire, oxygen is itself incombustible. Hydrogen on the other hand, is readily flammable and highly explosive when mixed with oxygen in proper proportion; its explosive range is wide and is not accurately known.

DANGER OCCASIONED BY WATER

We now come to the danger of water in relation to metals. When metals under certain conditions as noted further on, are placed in contact with water, their tendency to combine with oxygen is so great as to decompose or separate the water into its component parts, the metal combining with the oxygen and liberating the hydrogen. Sometimes the act of combination is attended with the generation of sufficient heat to ignite the hydrogen, or, when there is air present in favorable amounts, cause it to violently explode.

The following tables as compiled by Von Schwartz shows the behavior of various metals towards water, the latter being decomposed:

Table I.

Note: These metals decompose water at any temperature.

Potassium—Liberated hydrogen ignites at once explosively.
Rubidium—Liberated hydrogen ignites at once explosively.
Sodium—Liberated hydrogen ignites at once explosively.
Lithium—Liberated hydrogen ignites at once explosively, but less easily.
Caessium—Hydrogen liberated but not ignited.
Calcium—Hydrogen liberated but not ignited.
Borium—Hydrogen liberated but not ignited.
Strontium—Hydrogen liberated but not ignited.

Table II.

Note: These metals as solids only liberate hydrogen when the water is warm.

Magnesium—Slight decomposition at 86 to 212 deg. Fahr.
Zinc—Decomposition at 212 deg. Fahr.
Cadmium—Slight decomposition only.
Manganese—Exceedingly slight.
Titanium—Decompose at 212 deg. Fahr.
Uranium—Decomposition extremely low.

The metals noted in this table, when in pulverized or powdered form, liberate hydrogen, or in other words, decompose *water much* more readily. This is also true of aluminum.

From these tables we may therefore deduce the following rules:

Table I.—These metals should never be brought into contact with water, water moist solutions, damp bodies or steam.

Table II.—These metals should never be brought into contact with hot water or hot water moist materials.

The truth of the foregoing was very well illustrated by the recent Jane Street warehouse fire in New York. In this occurrence, the powdered magnesium, according to report, became ignited, and the water played upon it in the effort to extinguish it, liberated the hydrogen in the water. Of course, the hydrogen at once ignited violently and probably was due in part to the explosion which blew out one side of the elevator shaft.

Large flames of burning hydrogen have been observed when water has been employed to extinguish fires in aluminum dust.

EXTINGUISHING METAL FIRES

It is, therefore, apparent that water is worse than useless to extinguish a fire involving any of the previously noted metals; it is positively hazardous. In the case of aluminum dust, tests by the U. S. Bureau of Mines indicate that carbon tetrachloride is as dangerous as water, and this is also probably true of the other metal solids and powders herein mentioned. In one instance where aluminum dust is handled, oil is poured in the fire until the oil ignites and is then extinguished by carbon tetrachloride. By this process, the oil draws unto itself the fire in the aluminum powder, and as carbon tetrachloride is an efficient extinguisher for oil fires, the fire is readily put out. In another case, sand is poured carefully on the burning metal and the fire smothered in this way. It appears that fine shale dust, such as is used to neutralize coal dust in coal mines to prevent explosions, may also be used to advantage, as the shale makes a denser cover, thereby excluding the air more completely.

Very recently the Bureau of Mines conducted a series of tests for the purpose of determining proper materials for extinguishing fires in metal powders. For this purpose zinc dust was used. Water, carbon tetrachloride, silicon, tetrachloride, bicarbonate of soda, and a frothy mixture were used. Results of these tests indicated that the frothy mixture or foam type extinguishing agent is most efficient for fire in such materials. It was found that, after the frothy mixture had covered the fire, there was a tendency to re-kindle owing to the accumulation of gases beneath the foam covering, but the fire was quickly smothered by means of the contents of an additional extinguisher which was readily available.

CHLORATE OF POTASH

Necessity Shown for Prompt Liberation of Gases to Prevent Pressure in Event of Fire

Experience has shown that buildings occupied for the storage of chlorate of potash should be of light construction not over one story high. They should be well ventilated and so constructed that in case of fire gases could be liberated from the building. This would prevent production of pressure such as has developed in some risks of this kind. In event of an explosion the chance of serious damage by falling building material would be materially lessened owing to the lighter building construction. Buildings should be well detached from other buildings and no combustible material permitted within 100 feet. Buildings of this kind should not be located directly over a water main, especially fire lines. The practice of removing the wooden kegs containing the chlorate of potash should not be carried on within the main supply building, but should be removed to a well detached, small shelter, of light construction and no more of the chlorate of potash allowed to accumulate than may be needed for immediate use. All waste chlorate and rubbish, such as the refuse from the wooden kegs, should be removed at regular intervals and not permitted to accumulate. It is believed that sprinklers installed in a building occupied for the storage of chlorate of potash, under P. I. V. control, should have the valve lock closed. This would tend to reduce the chance of serious damage because of having water available with which temperature could be kept below the point at which there is danger of an explosion.

These conclusions are arrived at after inspection following a fire in a match factory. The fire evidently was caused by friction which occurred in the well detached, non-sprinklered, hollow tile chlorate of potash storage building. When discovered the fire was located under a truck used to transport the chlorate from the main supply room to the ante-room where it was removed from its wooden containers. Two explosions occurred. The latter one wrecked the entire building and distributed the contents, potassium chlorate, over that section of the premises. The two frame miscellaneous storage sheds, which were detached 40 feet and 95 feet respectively, were ignited and together with several other smaller sheds burned completely. The fire brigade of the plant and the

local fire department prevented the fire from being communicated to the main building.

Neither of the buildings mentioned were sprinklered. A section of the underground loop system, which passed under the chlorate of potash storage building, was damaged. This did not impair the supply to any great extent, owing to both fire pumps being run to capacity. Four hose streams attached to the plant's own hydrants were used and both sections on each side of the break were plugged until repairs could be made. The actual fire damage, including that caused by explosion, was thought to be $75,000. The building in which the fire occurred was occupied for and known as the chlorate of potash storage building. It was a one-story, tile building with a composition covered, four inch reinforced concrete roof, supported on unprotected steel and tile walls. It had a non-combustible floor supported on an earth fill inside a light foundation raised about three inches above grade. There were no communications.

This building held the main supply of chlorate of potash in its original wooden kegs. In a small room partitioned from the main storage room was an employee whose principal duty was to bring into the main factory building the required amounts of chlorate of potash as needed and remove the wooden kegs . For this he used an axe or a small bar. The potash was then taken to the main building on trucks.

It was shown that the assured had experienced fires at various times previous to this one, but none of them occurred in the main supply buildings and the supply of combustible material was less than at the time of the fire referred to here. Also, previous fires have occurred more in the open and it is the opinion of the inspector that the temperature had never been high enough nor the pressure from the burning gases sufficient to cause explosion.

OZOKERITE AND CAMPHOR SUBSTITUTES

Various Forms of Mineral and Fossil Wax, Sugar Dust and Pyroxylyn Plastic Receive Attention

Reports have been made recently by the Underwriters Bureau of New England on Ozokerite, Sugar Dust Explosions and Camphor Substitutes. Ozokerite is mineral wax, fossil wax, native paraffin. Of this product the bureau says:

This is found in natural deposits in Utah, Wyoming and Galicia, also in very small quantities in other parts of the world.

Properties.—A native waxlike hydrocarbon mixture, yellow brown to black or green in color, translucent when pure and having a greasy feeling. Specific gravity .85-.95, melting point varies from 70 to 300 degrees F. Soluble in benzine, benzol, turpentine, kerosene, ether, carbon disulphide, slightly soluble in alcohol, insoluble in water.

Uses.—Electrical insulation, rubber filler, paints, leather polish, sealing wax, candles, electrotyper's wax, carbon paper. It is sometimes distilled and worked up for paraffin wax. Is the basis for corroproof coatings for automatic sprinklers. Refined ozokerite called Ceresin is used largely as a substitute for beeswax. This varies in color from white to yellow.

Hazards.—The storage of crude ozokerite is attended with danger owing to the presence of 3 to 8 per cent. of petroleum ether, which is highly volatile and may render possible an explosive mixture with air in a closed room. Storerooms should be well ventilated; open flames such as stoves, fireplaces, lantern, etc., eliminated. Electric wiring to conform to standard requirements for hazardous places.

Refining plants are subject in a high degree to risk of fire and explosion on account of inflammable vapors liberated. Press cloths, filter papers, etc., used in this work are subject to spontaneous combustion.

The purified ozokerite is equal in hazard to wax or heavy fat. Where dissolved ozokerite is used the hazard is measured in proportion to the degree of inflammability of the solvent employed (benzine, benzol, carbon disulphide, etc.)

SUGAR DUST EXPLOSIONS

Sugar dust, as well as other organic dusts, may be exploded when in suspension in the air in certain proportions and under certain conditions. The danger of explosion increases with *the fineness* of the dust and effectiveness of the agencies

which may cause initial ignition. Other conditions being equal, a small moisture content favors explosion. The lowest ignition temperature for sugar dust is around 425 degrees C. Not only an open flame, but a hot bearing or an electric spark, static or otherwise, may start the explosion. The smallest amount of sugar dust per thousand cubic feet of air which permits of an explosion, is 72 grams when electric arc ignites the mixture; 370 grams for electric spark; and 180 grams for kerosene flame. Slight additions of methane greatly increase the danger of explosion. (Chemical Abstracts, Vol. 15, No. 12.)

The following rules for safety are advocated:

1. Mixture of air and inflammable gases must be avoided in rooms containing dust.
2. Revolving machine parts must be encased as is done in mines.
3. All electric wiring should conform to National Board standards for hazardous places, use of arc lamps prohibited.
4. The installation of dust removers is strongly recommended.

CAMPHOR SUBSTITUTES

Various substitutes for camphor have been tried in the manufacture of pyroxylin plastics. Some produce explosive compounds. Others liberate acid which makes the material unstable, while others have little or no solvent power for nitrocellulose.

Pinene hydrochloride (by itself non-hazardous) gelatinizes nitrocellulose but continues to liberate hydrochloric acid and has thereby caused explosions of pyroxlyin. Other chloro derivatives as well as nitro compounds are similarly dangerous.

The substitutes chiefly used in the United States are triphenyl phosphate and tritolyl phosphate (often called trieresyl phosphate), triacetin, ethyl acetanilide and other substances to a lesser degree.

Triphenyl phosphate is a white solid of low melting point. Tritolyl phosphate is a viscous liquid which becomes very thick and glassy at —30 degrees C. but does not solidify. In the liquid state both substances are colorless when pure. They are without odor or taste, non-volatile, boil at very high temperatures, are stable towards air and water and do not color on exposure to light. In this solvent action on nitrocellulose they resemble camphor. They are non-hazardous. It is claimed that pyroxylin plastics made with these materials are *superior* to those made with camphor in the following respects: *1, less inflammable*; 2, absolutely odorless; 3, resistant *to all external influences*; 4, cheaper.

Triacetin has been used to a certain extent to replace part of the camphor. Some manufacturers have experienced a fair degree of success with this substitute, while others claim it causes blistering and liberates acid.

Ethyl acetanilide or manol has been used in the United States but not very satisfactorily. It produces a soft compound which hardens on aging but becomes brittle. The higher cost, odor and discoloration in sunlight are serious objections.

ELECTRIC MOTORS IN OIL WELL DISTRICTS

Fire Hazard by Motor Where Wells Are Being "Swabbed" Claim That Use of Electric Motors Increases Rather Than Diminishes Likelihood of Fire

Hazards of electric motors in oil well derricks are presented by Clarendon Ions, insurance adjuster, of Dallas, Tex., who deals with the petition made in the Eastland-Ranger oil district, for reduction in charge under the Texas Oil Tariff for use of electric motors in derricks. Under the Texas schedules charge is made for derricks pumped by steam or electric power situated in derrick amounting to 2 per cent differential over the charge for detached power, and the electric power companies are seeking to have this charge removed, which it is held would be a grave injustice to the companies. Mr. Ions continues:

I was particularly interested in a somewhat broad general statement made to effect that out of some hundreds of motor equipments in use, no fires had occurred traceable to the motor. Further statement was made to effect that the electric power drive was no more hazardous than the detached steam power ordinarily used in central power house—shackle line pumping system.

From the detached position of an independent adjuster, I can no doubt offer the results of my observation and experience in this matter, as a disinterested observer, and my conclusions have been reached regarding the hazard of electric oil well power, following adjustment of two total losses in the Eastland-Ranger district, which I believe to have been due directly to the electric power installation.

WHERE LOSSES OCCURRED

The two risks upon which loss occurred, were situated in the heart of the "Pleasant Grove" District, where the closeness of derricks makes it extremely practical to hook up all wells with electric power, and as a result such installation is being made extensively. This district is in the hard line formation, and owing to the heavy gas pressure, the wells were large producers at first but the field has declined to a point where its production until recently was very small. The production of oil from a true sand structure seems to be much longer lived than is the case with a lime structure. This is due to the greater porosity of sand, permitting a constant seepage of oil into the well pumps for years. On the other hand, the lime offers high resistance to seepage, and

while the wells brought in, in the line district have been large producers at first, this ceases as soon as the gas pressure is reduced to the point where the capillary resistance of the fine rock pores, equals or balances the gas pressure.

Upon the failing of a lime district, the first expedient used to revive production is "shooting" the wells. A "shot" of nitro-glycerine is placed where it will shatter the lime structure and expose new areas of the structure to seepage and escape of the oil. This usually, if the shot is well placed, causes a revival of the heavy flow, but in time the base sediment will again clog the increased seepage face along the fissures and crevices created by the shot, and well will again fail. All this time the wells are being pumped, and gas pressure is gradually declining.

CHANGE CAUSED BY WETNESS OF GAS

Another feature which is plainly discernible is the change which occurs in the "wetness" of gas as the well gets older. At first the gas from the Eastland-Ranger District wells was extremely volatile "dry" gas, dissipating itself quickly in the atmosphere when escaping from open casing heads. As the wells have been worked, this gas has gotten richer, or to put it another way, the more volatile gas has escaped and the gas following it under lower pressure is a heavy wet gas, and in time after the shots, the wells have failed again, and all flow of oil and gas virtually ceased.

There remains only one expedient to increase the flow of these wells, that is putting them on vacuum which will again upset the balance formed between porosity of structure being equal in resistance to pressure of gas behind the oil. Now the state laws do not permit putting wells on vacuum, the object of this law being an inconsistency we need not discuss here, which seeks to prevent one man from drawing under vacuum, the oil belonging to his neighbor. However, the process known as "swabbing" is permitted, and this acts precisely in the same way as putting wells under vacuum, except that the process is intermitent, and the vacuum obtained is much lower than that obained under full process.

EFFECT OF SWABBING

The swab is a circular ool fitted with suction flanges and an interior valve which fits the well casing and operates with reference to the casing exactly the same as a pump plunger operates in the pump cylinder. This swab is dropped in the well by cable. Vacuum forms behind the swab bringing up the gas and inducing flow of oil from the lime structure. While *investigating the* two losses referred to, I investigated this *point carefuly,* and am informed that wells which have ceased

to make gas while on the pump, will develop under swabbing a gas pressure which blows the oil into the flow tanks, and that upon ceasing a swabbing operation, the well will continue to flow by heads for some time thereafter.

Now, the point relating to electric power and its hazard is this: In the two losses referred to, both wells were being continuously swabbed, and in both, electric power had been recently installed. Owing to the effort being made in that district to secure reduction in the charge for electric power in derricks, the assureds were very reluctant to admit that electric sparks could be connected with the fires, but I believe both fires to have been due directly to contact of wet gas with brush sparks on the motors.

GAS CLOSE TO GROUND

In both fires, the wells had been swabbed, and were being cleaned—that is to say the casing-head had been removed and balers were being run on sand lines. Claim was made that the friction drive of sand rell, which is run by throwing its metal friction pulley into contact with wooden band wheel, had caused friction sparks. It is inconceivablbe that this contact of metal and wooden pulleys would cause spark. On the other hand the baler was bringing up wet gas which would have a tendency to lie close to surface of ground, and the lower part of drive belt was running from casing-head toward motor, the upper portion of belt running from motor toward casing-head—therefore, the air currents set up between derrick and motor along belt house, would have a tendency to draw the wet gas into vicinity of motor and transformer.

RATING SPECIAL HAZARDS IN NEW YORK

Seven Classes To Be Used; Method of Charging for Faults of Management, Exposed Dwellings

Speaking of special hazards, Lawrence Daw, assistant manager of the Underwriters' Association of New York, says, respecting the new rating plan in its territory:

We have divided all special hazards into seven classes, starting with the least hazardous in No. 1 and the most hazardous in No. 7, such as kindling wood, celluloid and match factory.

Now, the old schedules, each one had made a charge for the specific hazards of that type of risk, like drying and finishing in a wood-worker, forging in a metal-worker, specific charge so much in each schedule for the things they did peculiar to that class of risk. We found out that all of the hundred specific special hazards that appertained to the various risks, could be boiled down to six classes. In other words, all these various special hazards could be condensed into six general groups, the first being a fire heat hazard, appertaining to nearly every risk; spontaneous ignition hazard, oil and volatile hazard, acid and chemical hazard, waste, dust and refuse disposal hazard, and crowded accumulation of inflammable material such as stock. This covers them all. So we removed the appendices of all these schedules and we found this method of grouping workable. They are graded into the different classes; for instance, the charge for a boiler and metal worker is about one-third of what it is for a boiler in the wood-worker. Isn't that logical? The hazard charges are increased, taking the mercantile schedule as a basis.

In a special hazard, the method of charging for faults of management will vary with the classification of the risk. For instance, no smoking in a foundry would take the minimum smoking charge; whereas smoking in a wood-worker would take the maximum. The amount of the charge will depend on the severity of the fault. No fault of management charge will ever be reduced from the charge originally made, until the fault is entirely eliminated. In other words, if there is a charge of 25 cents made for dirty conditions in a mercantile risk, and we receive an application to reduce it to 10 cents because it has been halfway cleaned up, nothing doing. All or *none.*

Exposed dwellings will be rated under the present dwelling

schedule, and the exposure charge as per the table. The rates will be published flat only.

The card system in the Underwriters' Association territory will be extended to all cities of 15,000 and over. The others will have an improved form of tariff book.

HAIR NET STOCK

Water Damage Runs to High Figure Through Failure of Watchman Service

One of the most disastrous fires in the New York metropolitan district this year was in the Flatbush Industrial Building, Brooklyn, a tenant manufacturing risk. The specific occupancy was a hair net factory operated by The Rieser Company.

It was a six-story building with basement, with fire resistive walls and floors, open finish. The stairs and elevators were cut off. The roof was fire resistive and the protection against exposure was not a factor.

The first notification of the fire was from the watchman. The plant was not in operation at the time of the fire, which was reported at 6:21 a. m. Sprinklers practically extinguished the fire, with slight fire loss and heavy water damage, caused by susceptibility of stock to water damage and lack of self-draining floors.

The sprinkler alarm is said to have operated, but this was connected only to an electric bell in the boiler room and the watchman did not hear it. The day watchman came into the boiler room shortly after 6 o'clock and he heard the bell. He turned in an alarm by telephone and the night watchman at the same time gave alarm from a window on the sixth floor.

The headway gained by this fire is attributed to failure by the night watchman to make all his rounds. Hourly rounds were made until 9 p. m. Electric transformers were being installed and the night watchman assisted in this work, making no rounds between 9 p. m. and 2:45 a. m. Two rounds were made then, the second being completed at 4:45 a. m. Then no round was made between 4:45 a. m. and the time of the fire. One of the watchman's stations was within a few feet of where the fire occurred. Some water was played from the standpipe hose until the fire department arrived. One hose stream from a city hydrant was used for one minute. The fire captain stated that the sprinkler valve was closed a few minutes after the first apparatus arrived.

Ordinarily, a fire of this kind would be extinguished by three sprinklers, but in this case 108 heads opened. This is ascribed to lack of ventilation and the flat slab ceiling. The damaged stock was all in open shelves, skidded 6 inches, with some goods in cases. The floors do not drain and the water descended through a stairway.

The large amount of water used at this fire was owing the watchman being at least a half hour late in making round and the absence of a positive sprinkler alarm. 1 lesson of the fire appears to be that full supervisory serv should be furnished and all floors should be arranged to dr to scuppers.

KNITTING MILL LINES

Difference Between Those Operating on Part and Full Process; Plants With Low Grade Cotton and Cotton Waste Are Bad Risks

Charles C. Dominge, Fire Underwriter

In New York City territory the knitting mills manufacturing sweaters and miscellaneous knit goods present only a mild hazard in that the "full process" is not carried on. The machinery consists of electrically driven winding frames and coning machines, ordinary sewing machines and knitting machines. The knitting machines should be cleaned of lint regularly. Considerable lint and fluff from the yarn is scattered throughout the premises during operation and only electric lights properly guarded should be used for the lighting system. A proper bin should be installed for the clippings which are sometimes found all over the floor. The dry-box should be of approved design and steamheated. In up-to-date plants the "Hoffman" combination steam-heated pressing machines, with their steam boiler attachments, may be found. These should be set on incombustible stands with proper clearance from woodwork. The repair shop with its lathes, planers and emery wheels, should have metal on the floor under the machines to catch the oily drip, and have a self-closing oily waste can installed near the machinery. If the finishing of cloth or yarn is done on the premises, the filling and brush machines and power extractors present but little hazard.

The "full process" knitting mill as encountered in outlying territories, performs the following work: washing, dyeing, picking, cutting, finishing, carding, spinning, knitting and drying. The hazards of ,the picking room consist of the light inflammable stock, sometimes containing foreign matter, passing through high-speed machines. These picking rooms may have a burr picker, mixing picker and duster, and lappers which discharge the stock after it passes through them into the gauze and blow room. The raw stock is cleaned and mixed for the picker room; it is transferred to the "card room," where the cards lay the fibre straight and form it into a loose roving preparatory to the spinning process. The main hazard in the card room is the presence of foreign matter in the stock, which emits sparks when coming in contact with *the rolls of* cards. It is well to remember that the higher the

grade of the output, the better the fire risk is. Where singeing is done, the character of the flame is an important feature.

It is best not to write the mill with the low-grade cotton and cotton waste. If the picker room is not properly cut off and the card room is over the finishing room, this is also a very poor arrangement and a company would do well to decline the line. Local experience in the knitting mill class has been very poor, the rate in most cases being entirely inadequate. Sprinklered knitting mills, on the other hand, show up fair.

INDEX OF ARTICLES TO BE FOUND IN THE FIRST

SPECIAL HAZARDS